Feasibility Study/Corrective Measures Study

for

Site 6A - Fuel Calibration Area, Site 10B - Engine Test House, and On-Site Southern Area Plume

Naval Weapons Industrial Reserve Plant

Calverton, New York

Engineering Field Activity Northeast
Naval Facilities Engineering Command

Contract Number N62472-03-D-0057

Contract Task Order 004

May 2006

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FEASIBILITY STUDY/CORRECTIVE MEASURES STUDY
FOR
SITE 6A - FUEL CALIBRATION AREA,
SITE 10B - ENGINE TEST HOUSE, AND ON-SITE SOUTHERN AREA PLUME

NAVAL WEAPONS INDUSTRIAL RESERVE PLANT
CALVERTON, NEW YORK

COMPREHENSIVE LONG-TERM
ENVIRONMENTAL ACTION NAVY (CLEAN) CONTRACT

Submitted to:
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Environmental Branch Code EV2
Naval Facilities Engineering Command
10 Industrial Highway, Mail Stop #82
Lester, Pennsylvania 19113-2090

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ACRONYMS AND ABBREVIATIONS

ARAR	Applicable or Relevant and Appropriate Requirement
ATSDR	Agency for Toxic Substances and Disease Registry
AWQC	Ambient Water Quality Criterion
BCF	Bioconcentration factor
BDAT	Best-demonstrated available technology
bgs	Below ground surface
BNP	Bimetallic nanoscale particle
BTEX	Benzene, toluene, ethylbenzene, and xylenes
BTU	British thermal unit
^oC	Degrees Celsius
CAA	Clean Air Act
CAMU	Corrective Action Management Unit
CAO	Corrective Action Objective
CERCLA	Comprehensive Environmental Response, Compensation, and Liability Act
cfm	Cubic feet per minute
CFR	Code of Federal Regulations
CLEAN	Comprehensive Long-Term Environmental Action Navy
CMS	Corrective Measures Study
COC	Contaminant of concern
CRQL	Contract-Required Quantitation Limit
CSF	Cancer slope factor
CTO	Contract Task Order
CWA	Clean Water Act
DOT	Department of Transportation
DPT	Direct-push technology
DRO	Diesel range organics
EBCT	Empty bed contact time
ECL	Environmental Conservation Law
EE/CA	Engineering Evaluation/Cost Analysis
E.O.	Executive Order
EPA	United States Environmental Protection Agency
^oF	Degrees Fahrenheit
FS	Feasibility Study
ft/day	feet per day
ft^2	Square feet

GAC	Granular activated carbon
GOCO	Government-Owned Contractor-Operated
gpm	Gallon(s) per minute
GRO	Gasoline range organics
HI	Hazard index
HQ	Hazard quotient
HRC	Hydrogen-releasing compound
IAS	Initial Assessment Study
ICR	Incremental cancer risk
IEUBK	Integrated Exposure Uptake Biokinetic
IR	Installation Restoration
IRIS	Integrated Risk Information System
ISCO	In situ Chemical Oxidation
K_{oc}	Organic carbon partition coefficient
K_{ow}	Octanol-water partition coefficient
LDR	Land Disposal Restriction
LOAEL	Lowest-observed-adverse-effect-level
MCL	Maximum Contaminant Level
MCLG	MCL Goal
MDL	Method detection limit
MF	Modifying factor
MI	Mobility index
MPC	Marine Pollution Control
NAAQS	National Ambient Air Quality Standard
NEPA	National Environmental Policy Act
NESHAP	National Emission Standards for Hazardous Air Pollutant
NOAEL	No-observed-adverse-effect-level
NPDES	National Pollutant Discharge Elimination System
NSPS	New Source Performance Standards
NWIRP	Naval Weapons Industrial Reserve Plant
NYCRR	New York State Code of Rules and Regulations
NYSDEC	New York State Department of Environmental Conservation
O&M	Operations and maintenance
ORC	Oxygen-releasing compound
OSWER	Office of Solid Waste and Emergency Response
PAH	Polynuclear aromatic hydrocarbon
PCB	Polychlorinated biphenyl

POTW	Publicly owned treatment works
ppb	Part(s) per billion
PPE	Personal protective equipment
ppm	Part(s) per million
PQL	Practical quantitation limit
PRG	Preliminary Remediation Goal
RBC	Risk-Based Concentration
RCRA	Resource Conservation and Recovery Act
RFA	RCRA Facility Assesment
RfD	Reference dose
RFI	RCRA Facility Investigation
RI	Remedial Investigation
SAGW	Source Area Groundwater
SDWA	Safe Drinking Water Act
SMCL	Secondary MCL
SOP	Standard Operating Procedure
SPDES	State Pollutant Discharge Elimination System
SSL	Soil Screening Level
STARS	Spill Technology and Remediation Series
SVE	Soil vapor extraction
SVOC	Semivolatile organic compound
TAGM	Technical and Administrative Guidance Memorandum
TBC	To Be Considered
TCLP	Toxicity Characteristics Leaching Procedure
TDS	Total dissolved solids
TOC	Total organic carbon
TOGS	Technical and Operational Guidance Series
TPH	Total petroleum hydrocarbons
TSCA	Toxic Substances Control Act
TSD	Treatment, storage, and disposal
TtNUS	Tetra Tech NUS, Inc.
TU	Temporary unit
UF	Uncertainty factor
USC	United States Code
USGS	United States Geological Survey
UST	Underground storage tank
VOC	Volatile organic compound

1.0 INTRODUCTION

1.1 SCOPE AND OBJECTIVES

The Naval Facilities Engineering Command, Engineering Field Activity Northeast has issued Contract Task Order (CTO) 004 to Tetra Tech NUS, Inc. (TtNUS) under the Comprehensive Long-Term Environmental Action Navy (CLEAN) Contract N62472-03-D-0057 to perform a Feasibility Study (FS) and Resource Conservation and Recovery Act (RCRA) Corrective Measure Study (CMS) for Site 6A - Fuel Calibration Area, Site 10B - Engine Test House, and the Southern Area at the Naval Weapons Industrial Reserve Plant (NWIRP) located in Calverton, New York. Contaminant migration from Sites 6A and 10B caused groundwater contamination observed in the Southern Area. This CMS addresses contaminated soil and groundwater at Sites 6A and 10B and the on-site component of the Southern Area groundwater. A separate CMS will be prepared to address the off-site component of the Southern Area groundwater.

This work is part of the Navy's Installation Restoration (IR) Program, which is designed to identify contamination at Navy and Marine Corps lands/facilities resulting from past operations and to institute corrective measures, as needed. There are typically four distinct stages. Stage 1 is the Preliminary Assessment [formerly known as the Initial Assessment Study (IAS)]. Stage 2 is a RCRA Facility Assessment (RFA) - Sampling Visit (also referred to as a Site Investigation), which augments the information collected in the Preliminary Assessment. Stage 3 is the RCRA Facility Investigation (RFI)/CMS [also referred to as a Remedial Investigation (RI)/FS], which characterizes the contamination at a facility and develops options for remediation of the site. Stage 4 is the Remedial Action, which results in the control or cleanup of contamination at sites. This report has been prepared under Stage 3 (CMS).

This work was conducted in accordance with the requirements of the New York State RCRA Hazardous Waste Permit for the facility (NYSDEC 1-4730-00013/00001-0), dated March 25, 1992. New York State Department of Environmental Conservation (NYSDEC) is the lead oversight agency. This work was also conducted in accordance with the requirements of the previous United States Environmental Protection Agency (EPA) facility permit (EPA ID Number NYD003995198), dated May 11, 1992. The EPA supports NYSDEC in its oversight activities. The requirements of both permits appear to be the same, although the terminology and format vary. The facility is also a State Superfund site. The FS/CMS was conducted in accordance with the requirements of the NYSDEC Division of Solid & Hazardous Materials Part 373 Permit that was issued to the Navy on April 18, 2000 under the NYSDEC implementing regulations [6 New York State Code of Rules and Regulations (NYCRR) Part 621]. This permit supercedes and replaces the original Part 373 Permit to Operate a Hazardous Waste Storage Facility that was issued to then Grumman Aerospace Corporation on March 25, 1992. The new permit, issued only to the

Department of the Navy, deals exclusively with those Solid Waste Management Units that remain on the former NWIRP Calverton property and any corrective actions that may be required to adequately address each site. Although the Part 373 Permit is the enforceable document governing the Navy's remedial actions, the NYSDEC State Superfund group, located in the Albany office, retains primary responsibility for regulatory oversight of the Navy's actions. The Navy has agreed to a request by the NYSDEC State Superfund group to utilize terminology associated with the NYSDEC State Superfund program, which is closely related to the federal Comprehensive Environmental Response, Compensation, and Liability Act (CERCLA) program. The CERCLA terminology parallels the RCRA terminology. The implementation phases of each program have been determined to meet the substantive requirements of both programs and will also satisfy the corrective action requirements included in Module III of the Part 373 Permit. Site 6A is listed as a Class 2 Inactive Hazardous Waste Site on the NYSDEC Registry.

The objectives of the CMS are as follows.

- Identify Applicable or Relevant and Appropriate Requirements (ARARs) and To Be Considered (TBC) criteria.

- Identify risk-based action levels that are protective of human health and the environment.

- Develop Corrective Action Objectives (CAOs), which identify chemicals of concern, receptors, pathways, and preliminary remediation goals. The preliminary remediation goals are based on chemical-specific ARARs, TBCs, and risk-based action levels.

- Identify and screen Corrective Measures Technologies.

- Develop Corrective Measures Alternatives.

- Conduct a detailed analysis and comparative analysis of Corrective Measures Alternatives.

- Present corrective measure recommendations.

1.2 ORGANIZATION OF CORRECTIVE MEASURES STUDY

This CMS consists of five sections. Section 1.0 is this introduction. Section 2.0 provides a description of current site conditions. Section 3.0 identifies ARARs, TBCs, and CAOs. The identification and screening of Corrective Measure Technologies and the development of Corrective Measure Alternatives are conducted in Section 4.0. Section 5.0 presents the evaluation of Corrective Measures Alternatives, and presents corrective measure recommendations.

1.3 ACTIVITY BACKGROUND INFORMATION

1.3.1 Facility Location

Site 6A - Fuel Calibration Area and Site 10B - Engine Test House are located within the confines of the NWIRP in Calverton, Suffolk County, New York, (see Figures 1-1 and 1-2). The facility is located within the Town of Riverhead. Calverton is located on Long Island approximately 80 miles east of New York City.

The NWIRP consists of four separate parcels of land totaling approximately 358 acres. Eight Navy IR sites are included within these parcels as follows. The location of the parcels and sites are presented in Figure 1-2.

Parcel A (32 acres)

Site 2 - Fire Training Area

Parcel B1 (40 acres)

Site 6A - Fuel Calibration Area
Site 10B - Engine Test House

Parcel B2 (131 acres)

Southern Area

Parcel C (10 acres)

Site 7 - Fuel Depot
Site 10A - Jet Fuel Systems Laboratory

Parcel D (145 acres)

Site 1 - Northeast Pond Disposal Area
Site 9 - ECM Area

1.3.2 Facility History

The NWIRP Calverton has been owned by the United States Navy since the early 1950s. At that time, the property was purchased from a number of private owners. The facility was expanded in 1958 through additional purchases of privately owned land. Northrop Grumman Corporation (previously Grumman Corporation) has operated the facility since its construction (Navy, 1986).

The NWIRP Calverton was constructed in the early 1950s for use in the development, assembly, testing, refitting, and retrofitting of Naval combat aircraft. Northrop Grumman was the sole operator of the facility, which was known as a Government-Owned-Contractor-Operated (GOCO) installation. Construction was completed in 1954. The facility supported aircraft design and production at the Northrop Grumman Bethpage, New York NWIRP.

The majority of industrial activities at the facility were confined to the developed area in the center and south-central portion of the facility, between the two runways. Industrial activities at the facility were related to the manufacturing and assembly of aircraft and aircraft components. Hazardous waste generation at the facility was related to metal finishing processes such as metal cleaning and electroplating. The painting of aircraft and components resulted in additional waste generation (Navy, 1986; HNUS, 1992).

Northrop Grumman operations at the facility ended in February 1996. In September 1998, the majority of the land within the developed section of the facility was transferred to the Town of Riverhead for redevelopment. Because of the need for additional environmental investigation and the potential need for remediation, the Navy retained four parcels of land within the developed section. The four parcels and associated Navy IR Sites are presented on Figure 1-2.

In September 1999, 2,935 acres of undeveloped land outside of the fenced areas were transferred to NYSDEC, which will continue to manage the property for resource conservation and recreational uses. An additional 140 acres of the northwestern buffer zone was transferred to the Department of Veterans Affairs and will be used for expansion of the Calverton National Cemetery.

1.4 PHYSICAL CHARACTERISTICS OF STUDY AREA

1.4.1 <u>Climate and Meteorology</u>

The NWIRP Calverton is located in an area classified as a humid-continental climate. Its proximity to the Atlantic Ocean and Long Island Sound add maritime influences to this classification (NOAA, 1982).

The average yearly temperature at the NOAA Riverhead Research Station, located 4.5 miles northeast of the site, is 52.2 degrees Fahrenheit (°F), with a mean maximum average monthly temperature of 73.3°F in July and a minimum average monthly mean temperature of 30.9°F in January. Annual precipitation at the Riverhead Station averages 45.32 inches. The highest monthly average precipitation is 4.46 inches occurring in December, and the lowest is 2.90 inches occurring in July. The average yearly evapotranspiration rate is 29 inches, resulting in a net annual precipitation rate of 16.32 inches. A 2-year, 24-hour rainfall can be expected to bring 3.4 inches of precipitation (NOAA, 1982; United States Department of Commerce, 1961).

1.4.2 Topography

The NWIRP Calverton is located in an area underlain by permeable glacial material and characterized by limited surface water drainage features. Normal precipitation at the facility is expected to infiltrate rapidly into the soil. The majority of the facility is located within the Peconic River drainage basin. Extensive wetland areas and glacially formed lakes and ponds are located southwest and south of the facility. NWIRP Calverton occupies a relatively flat, intermorainal area. The topographic relief at NWIRP is 54 feet; elevations range from 30 to 84 feet above mean sea level.

1.4.3 Surface Water Hydrology

The majority of the facility is located within the Peconic River drainage basin. Extensive wetland areas and glacially formed lakes and ponds are located southwest and south of the facility. The eastward-flowing Peconic River is located approximately 2,000 feet south of the facility at its closest point. The surface water in the Peconic River is classified as Class C, which is suitable for fish propagation and survival and for primary and secondary contact recreation. The State of New York designated the upper 10.5-mile reach of the Peconic River as a Scenic River and the lower 5.5-mile reach as a Recreational River.

Based on topography, groundwater is expected to flow southward and discharge to the ponds and wetland areas to the south and southwest, and ultimately be received by the Peconic River via overland flow. The Peconic River flows into Peconic Lake. The Peconic River is tidally influenced downstream of the dam on Peconic Lake, located 3.2 stream miles from the site, and discharges to Peconic Bay, which is 8.5 stream miles from the facility.

Major surface water features near the Calverton facility include McKay Lake, the Northeast Pond, and the North Pond. McKay Lake is a groundwater recharge basin located north of River Road, midway along the southern site border. The Northeast Pond is located at the northeastern corner of the facility (Site 1 - Northeast Pond Disposal Area), and North Pond is located near the southwestern corner of the facility. Several small drainage basins exist near Site 6A. All of these ponds and drainage basins are land locked, with the exception of McKay Lake, which has an intermittent discharge to Swan Pond located 1,500 feet to the south. Swan Pond, approximately 55 acres in size, discharges to the Peconic River 1.6 stream miles south of McKay Lake via a string of cranberry bogs (USGS, 1967; Navy, 1986).

The Northeast Pond area actually consists of two ponds, a 2.3-acre pond directly east of Site 1 and an approximately 1-acre pond located less than 500 feet to the southeast of Site 1 (Shannon's Pond). Both of these ponds lie in land-locked depressions and may be of glacial origin. Observations made during RFI soil boring drilling activities in Site 1 indicated that the main pond elevations are similar to the local groundwater elevation. As stated earlier, no outfalls exist from the ponds; they are expected to receive limited overland surface water flow from surrounding land in the northeastern corner of the site (USGS, 1967).

The small drainage basins located near Site 6A are land locked and receive limited surface water runoff from immediately adjacent areas. Surface water runoff from Site 6A is collected by drainage ditches paralleling the southern and eastern edges of the paved area. The ditches enter a southward-flowing culvert at the southeastern corner of Site 6A; the culvert ends approximately 250 feet west of Site 10B, south of the road. A drainage ditch flows southward 500 feet from the outfall and enters a depression containing two small ponds. These ponds are located approximately 1,500 feet south of Site 6A. Runoff from Site 2 flows to the southeast; the nearest potential receiving water is Swan Pond, located 2,000 feet to the southeast. Runoff from the Site 7 flows eastward via a very shallow slope into woodlands. No direct drainage pathway to a surface water body exists. Surface water runoff for the area at the end of Runway 32-14 is expected to flow approximately 500 feet south to the Peconic River. The elevation of the runway at this location is approximately 20 feet above the river in this area.

1.4.4 Geology and Soils

Geologic Setting

NWIRP Calverton lies within the Atlantic Coastal Plain Physiographic Province. Generally, this region can be characterized as an area of relatively undissected, low-lying plains. The Atlantic Coastal Plain is underlain by a thick sequence of unconsolidated deposits. The surface topography has been created or modified by Pleistocene glaciation (Isbister, 1966).

Ground surface elevations on Long Island range from sea level to approximately 400 feet above mean sea level. The two most prominent topographic features in the Long Island area are the Ronkonkoma terminal moraine and the Harbor Hill end moraine. These east-west trending highlands mark the southern terminus or maximum extent of two glacial advances. The older Harbor Hill moraine lies along the northern shore of Long Island, the younger Ronkonkoma moraine basically bisects the island. NWIRP Calverton occupies a relatively flat, intermorainal area between these two features. The topographic relief at NWIRP is 54 feet; elevations range from 30 to 84 feet above mean sea level (McClymonds and Franke, 1972).

NWIRP Calverton is underlain by approximately 1,300 feet of unconsolidated sediments consisting of four distinct geologic units. These units, in descending order, are the Upper Glacial Formation, the Magothy Formation, the Raritan Clay Member of the Raritan Formation, and the Lloyd Sand Member of the Raritan Formation (McClymonds and Franke, 1972).

The glacial sediments beneath the NWIRP have a maximum thickness of approximately 250 feet and consist of both glacial till and outwash deposits. Till is deposited directly by the ice, while outwash deposits are laid down by meltwater-supplied glaciofluvial systems. The till in Suffolk County ranges from 0 to 150 feet in thickness and generally consists of poorly sorted to unstratified sediments. The outwash deposits consist chiefly of well-sorted and stratified sand and gravel. One important characteristic of outwash deposits is their high degree of heterogeneity. Lithologies may vary widely over relatively short vertical and horizontal distances.

The Cretaceous-age Magothy Formation underlies the Upper Glacial Formation and is approximately 520 feet thick. The Magothy Formation chiefly consists of stratified, fine to coarse sand and gravel.

The Cretaceous-age Raritan Clay Member of the Raritan Formation underlies the Magothy Formation and is approximately 170 feet thick. The Raritan Clay consists of clay and silty clay.

The Lloyd Sand Member of the Raritan Formation underlies the Raritan Clay and is approximately 400 feet thick. The Lloyd Sand consists chiefly of fine to coarse sand and gravel.

The unconsolidated sediments beneath the site unconformably overlie crystalline bedrock consisting of schist, gneiss, and granite. The regional dip is to the south and southeast. All of the geologic units dip in these directions, although to varying degrees (McClymonds and Franke, 1972).

1.4.5 Hydrogeology

The unconsolidated sediments that underlie the NWIRP are generally coarse grained with high porosities and permeabilities. These factors create aquifers with high yields and high transmissivities.

The Upper Glacial Formation, the Magothy Formation, and the Lloyd Sand are the major regional aquifers. The Upper Glacial and Magothy aquifers are of principal importance in Suffolk County because of their proximity to the land surface. The Lloyd Sand is not widely exploited because of its depth (McClymonds and Franke, 1972).

The Upper Glacial aquifer is widely used as a source of potable water in Suffolk County. The water table beneath the NWIRP lies within this aquifer. Porosities in excess of 30 percent have been calculated for the Upper Glacial aquifer in adjoining Nassau County, Long Island. The estimated hydraulic conductivity of this aquifer is 270 feet per day (ft/day).

The Magothy aquifer is widely used as a source of potable water in Suffolk County. The most productive units are the coarser sands and gravels. The permeability of the Magothy is high; hydraulic conductivities have been calculated in excess of 70 ft/day.

The Upper Glacial and Magothy aquifers are believed to be hydraulically interconnected and to function as a single unconfined aquifer. On-site well logs, previous hydrogeological investigations, and geologic mapping indicate that although clay lenses are present in both aquifers that may create locally confining and/or perched conditions, these lenses are not widespread and do not function as regional aquitards (McClymonds and Franke, 1972; Fetter, 1976).

The Raritan Clay has a very low permeability (approximately 3×10^{-5} ft/day) and hydrologically acts as a regional confining layer. The confining nature of this unit is believed to minimize potential contamination migration to the underlying Lloyd Sand aquifer (McClymonds and Franke, 1972).

The Lloyd Sand is a potential aquifer that has not been extensively developed due to its depth and the abundant water available in the overlying aquifers. Estimated hydraulic conductivities for the Lloyd Sand range from 20 to 70 ft/day.

The NWIRP Calverton saddles a regional groundwater divide, with groundwater beneath the northern half flowing to the northeast and groundwater beneath the southern half of the NWIRP flowing to the southeast. Based on water level measurements obtained during the RFI, the groundwater flow direction at both Site 2 and Site 6A is to the southeast. The groundwater flow direction at Site 7 is to the east. The groundwater flow direction at Site 1 is to the northeast.

The Peconic River basin is the likely discharge point for groundwater in the shallow aquifer zones in the southern portion of the NWIRP. Long Island Sound is the likely discharge point for groundwater in the shallow aquifer zones in the northern portions of the facility.

1.4.6 Water Supply

Groundwater serves as the source of drinking water for the population residing within a 4-mile radius of the facility. Private wells, wells on two government-owned facilities (Town of Riverhead and Brookhaven National Laboratory), and three municipal water systems (Riverhead Water District, Shorewood Water

Company, and Suffolk Water Company) supply the drinking water needs of the study area. Two public water supply wells (former production wells) are located on the former NWIRP Calverton property. These wells continue to operate with carbon treatment to address low concentrations of volatile organic compounds (VOCs).

1.4.7 Surrounding Land Use

The land surrounding the Calverton facility in all directions is primarily agricultural or wooded, with scattered residences and commercial establishments. Wildwood State Park and Long Island Sound are located 2.3 miles and 2.75 miles north, respectively. The Town of Riverhead is located 4.25 miles to the east. A golf course, Swan Pond, and a large area of swamps, wetlands, and cranberry bogs are located immediately south of the facility. The Long Island Railroad passes within 1,000 feet of the southeastern corner of the facility. Brookhaven National Laboratory is located 2 miles southwest of the facility.

1.4.8 Ecology

According to the United States Department of the Interior, Fish and Wildlife Service, no federally listed endangered or threatened species reside within a 4-mile radius of the study area. Transient individuals of endangered species such as the Bald Eagle (*Haliaeetus leucocephalus*) may occur within the study area.

Information provided by NYSDEC and the New York Natural Heritage program indicated that several New York State endangered and threatened animal species exist within the study area. The most notable, tiger salamander (*Ambystoma tigrinum*), may occur on site in the ponds adjacent to Site 6A, and possibly the Northeast Pond Disposal Area. Other species include the northern cricket frog (*Acris crepitans*) and the least tern (*Sterna Antillarum*). Although numerous additional endangered and threatened plant species occur within the Calverton facility boundary, none are believed to be present at Site 6A or Site 10B. Some may be present in the Southern Area.

According to the information supplied by NYSDEC, the wetland areas surrounding the Peconic River, including Swan Pond, include of significant habitat for many State endangered and threatened animals and plants.

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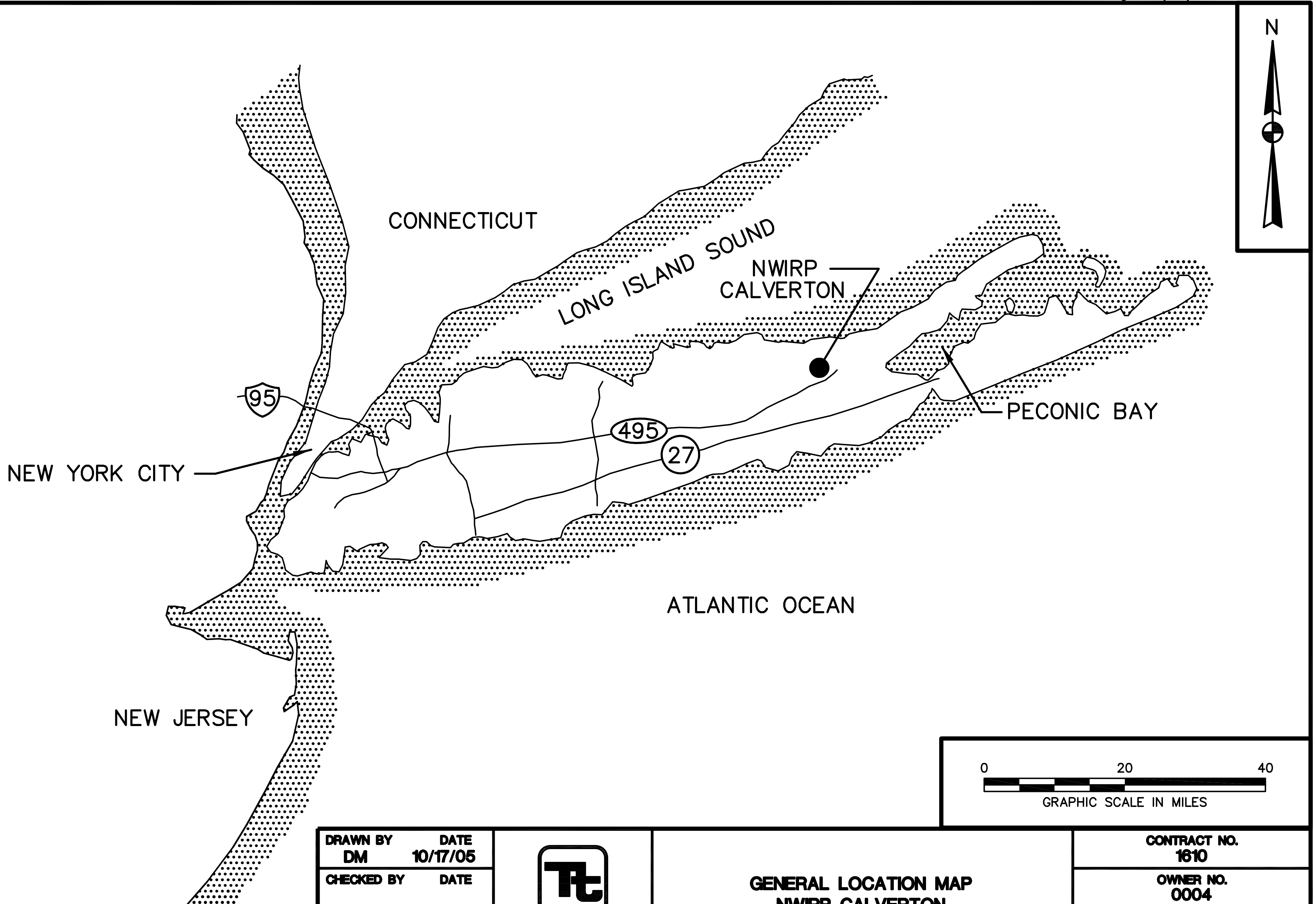

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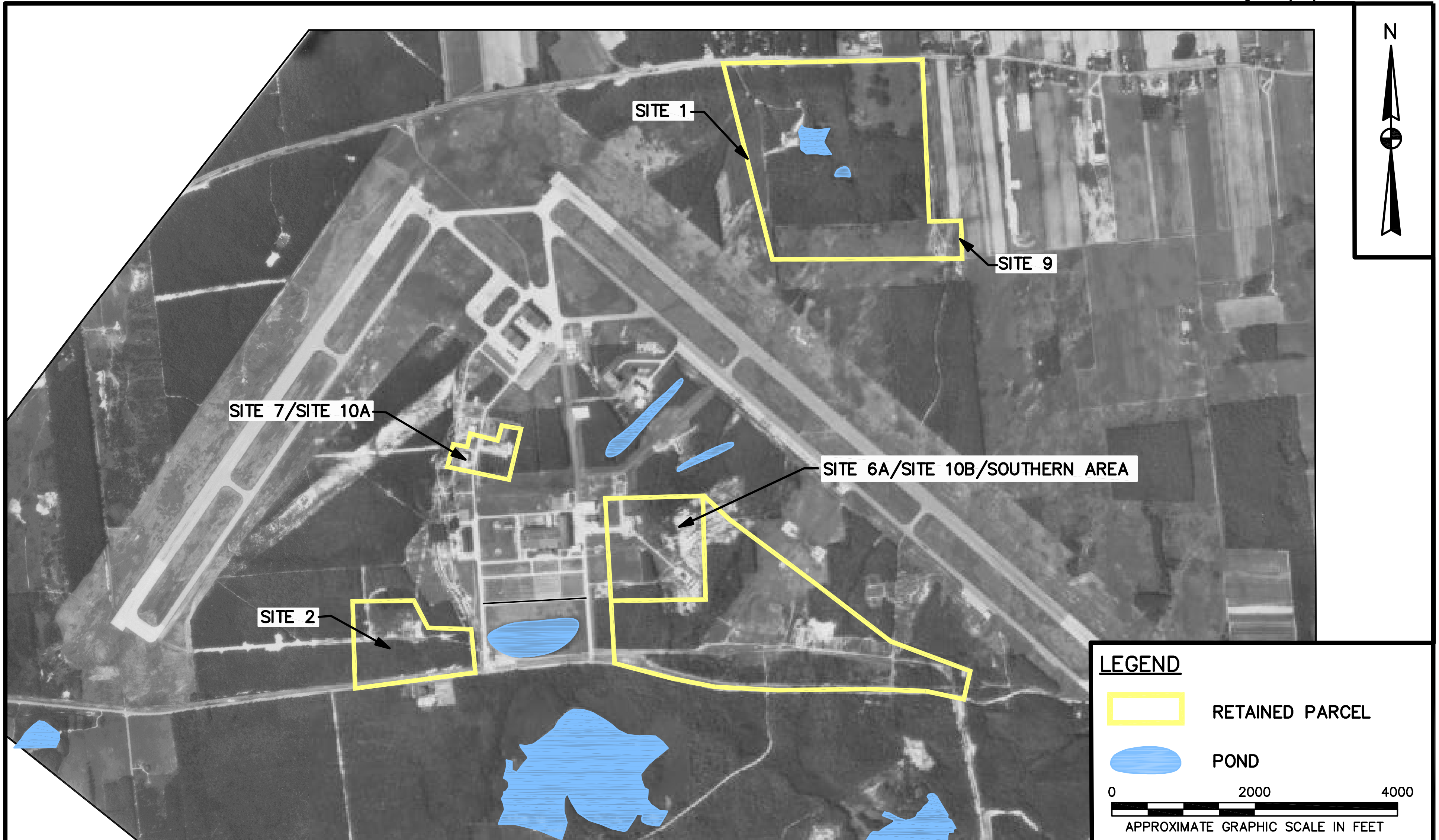

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2.0 DESCRIPTION OF CURRENT CONDITIONS

This section presents a summary of the current conditions at Site 6A, Site 10B, and the on-site portion of the Southern Area. The discussions were extracted from other documents including the RFI (HNUS, 1995a), draft Phase 2 RFI (CF Braun, 1998), Engineering Evaluation/Cost Analysis (EE/CA) for Sites 2, 6A, 7, and 10B (TtNUS, 1998), Phase 2 RI Site 6A - Fuel Calibration Area, Site 10B - Engine Test House, and Southern Area (TtNUS, 2001); and Data Summary Report for Site 6A and Southern Area (TtNUS, 2005). The following information is presented for the sites:

- Site description, including site history and remedial activities/interim actions
- Geology and hydrogeology
- Nature and extent of contamination
- Contaminant fate and transport
- Human health risk assessment
- Contaminants of concern (COCs)

2.1 SITE DESCRIPTION

2.1.1 <u>Site 6A - Fuel Calibration Area</u>

Site 6A and related facilities were used in the testing of aircraft fuel and engine systems. Aircraft fuel delivery systems were pressurized with fuel in the calibration area to test for leaks. The testing may have resulted in frequent, small fuel spills to the area's pavement (Navy, 1986). Minor maintenance and repairs to the fuel and engine systems were also conducted at the site. Solvents were used during the maintenance and repair activities and were likely spilled during their use.

Site 6A consist of new and old fuel calibration pads (see Figure 2-1). The old fuel calibration pad was located in what is now an open, grass-covered field. The new fuel calibration pad is located to the north and east of the old fuel calibration pad on a concrete apron. The concrete apron between the two fuel calibration pads was also used for the same activity. A shed, piping, and fuel filtering devices were located in the area in the 1980s (USGS, 1967; Navy, 1986). The equipment has since been removed.

An open field, approximately 10 acres in area, is located immediately south of the old and new calibration pads. The old fuel calibration pad was located at the northwestern corner of the field, in an area now partially covered by a wastewater treatment facility. No physical evidence exists of the former calibration area. An area east of the wastewater treatment plant and south of the fuel pad is the former site of a septic leach field (USGS, 1967; Navy, 1986). The septic system was active before the construction of the facility's sanitary sewage treatment plant in 1970. The leach field is believed to have received primarily sanitary wastes; however, it is not known whether industrial process wastes entered the leach field (Navy, 1986). Testing conducted in this area found no evidence of significant environmental contamination (HNUS, 1995b).

The surface topography at Site 6A slopes very gently to the south and east. Drainage swales are located parallel to the southern and eastern edges of the pad. The two swales meet to the east of the southern corner of the pad and enter a southward-trending buried culvert. The culvert discharges to another drainage ditch approximately 625 feet south of the pad. This ditch continues to a shallow pond located approximately 1,500 feet south-southeast of the pad (USGS, 1967).

Aircraft hangers and painting shops were located east of the pad. Several small drainage collection ponds are located to the north, east, and south of Site 6A, all within 1,500 feet (USGS, 1967; Navy, 1986).

Three ancillary structures to Site 6A are located to the southeast of the site. These include the covered engine runup area, the hush house, and the Engine Test House (Site 10B). The engine runup area was used to test jet engines and fuel systems for leaks while operating the engines at elevated speeds. An excavated area several acres in size is located east of the engine runup area blast fence; its use is unknown. The hush house is a specially constructed building that allows aircraft engines to be operated at high speeds while containing the associated noise. Site 10B (see Figure 2-1) was outfitted to operate jet engines before installation on aircraft.

The primary environmental concern at Site 6A involves the spillage of aircraft fuels. According to the IAS (Navy, 1986), as many as 230 gallons of fuel were reportedly spilled in this area. The majority of the spillage probably occurred in the areas surrounding the new fuel calibration pad.

Eighteen monitoring wells were installed south and southeast of the fuel calibration pad by Marine Pollution Control (MPC) between March 1984 and November 1987. A product recovery unit including a pumping well, an oil recovery well, and an oil/water separator tank was installed in 1987. The tank is connected to a pipe that follows the drainage ditch paralleling the southern edge of the new calibration pad. The recovery system pipe ends within the underground culvert. Red iron staining was observed during the site investigation in the ditch adjacent to the oil/water tank separation outfall and at the end of the culvert. The staining in the ditch near the oil/water separator reportedly resulted from a break in the piping early in 1990 (CF Braun, 1998). This system was shut down in December 1993 after approximately 1,200 gallons of petroleum product had been removed from the site. Passive free product recovery from individual wells via hand bailing continued after 1993, and an additional 700 gallons of petroleum product (total of 1,900 gallons) was recovered as of February 1996. Removal of free product since that time has been minimal (i.e., less than 1 gallon).

2.1.2 Site 10B - Engine Test House

Site 10B is located approximately 1,000 feet south of Site 6A (see Figure 2-1). The area consists of a building, surrounding pad, sparse woods, and open grassy areas. A drainage swale and culvert from Site 6A run adjacent to and hydraulically upgradient of Site 10B. Groundwater from Site 6A can enter this swale and flow past Site 10B. Also, from the late 1980s to the early 1990s, groundwater from Site 6A was discharged into this drainage swale and culvert. As a result, a portion of the chlorinated VOC-contaminated groundwater present at Site 10B can be attributed to Site 6A.

This area was initially evaluated as part of the 1995 RFA cesspool/leach field investigation (HNUS, 1995b). Subsequent testing during the RFA Addendum (CF Braun, 1997) found that the cesspool at this site was not a source of environmental contamination. However, during this testing, fuel-type contamination [benzene, toluene, ethylbenzene, and xylenes (BTEX)] was found in the area of an underground storage tank (UST) removed in the mid-1990s. Based on an interview with Northrop Grumman, approximately 80 cubic yards of fuel-contaminated soils were excavated during the removal of the UST. The excavation did not continue under the concrete slab at Site 10B.

2.1.3 Southern Area

The Southern Area is located to the southeast of Site 10B and extends off site to the southeast. The area was investigated because a Suffolk County monitoring well demonstrated the presence of chlorinated VOCs in groundwater downgradient of the facility. There are no known or suspected contaminant sources within this area. However, this area is hydraulically downgradient of Site 10B, Site 6A, and the general industrial complex at the facility. Groundwater flow through this area is to the southeast, with the Peconic River or Flander’s Bay being potential discharge points.

The area is mostly wooded, and includes two shallow ponds near the northern edge. The ponds receive runoff through a drainage swale and culvert from Site 6A. From the late 1980s to the early 1990s, groundwater from Site 6A was discharged into this drainage swale and culvert and into the western pond. As a result, the presence of chlorinated VOC contaminated groundwater at the Southern Area may be attributable to Site 6A.

2.2 GEOLOGY

The geology at NWIRP Calverton consists of a mixture of sandy and clayey deposits. Figures 2-2 and 2-3 are cross section location maps, and Figures 2-4 and 2-5 are geological cross sections for the area. The upper 120 to 130 feet of subsurface materials consist primarily of fine to medium sand, with thin to thick clayey layers also encountered within the predominantly sandy deposits.

Minor amounts of fill, consisting primarily of a mixture of sand, silt, and clay, were also found at shallow depths (0 to 6 feet) in some areas. From this depth to approximately 60 feet below ground surface (bgs), fine to medium sand is present. A silty clay layer was encountered at a depth of approximately 60 to 90 feet. In the southeastern portion of the study area (Off Site Southern Area), this clay unit appears to pinch out and was not encountered in the borings drilled near the Peconic River. Underlying this silty clay unit is approximately 40 feet of fine to medium sand. Another silty clay unit is encountered from a depth of 130 to 180 feet bgs.

The geologic units encountered within the study area appear to be generally flat-lying, consistent with what would be expected for the glacial deposits on Long Island. The upper contact of the Magothy Formation, being an erosional surface, is expected to be flat-lying to undulating, reflecting the former topography, even though the formation itself is known to dip to the south.

2.3 HYDROGEOLOGY

During the Phase 2 RI (TtNUS, 2001), a focused groundwater investigation was performed in the Southern Area to determine whether the Peconic River was the discharge point for contaminated groundwater (to a depth of 100 feet bgs) that migrated from the facility, or conversely whether some groundwater bypassed the river and migrated to areas further south. The study involved the installation of several well clusters on both sides of the river and in the immediate vicinity of the river, the installation of two staff gauges in the river, and the collection of four rounds of water level data from the wells and staff gauges. Potentiometric surface interpretations based on water level data from the well clusters indicate that the river is the ultimate groundwater discharge point in this area because the water levels along the river were lower than water levels for both shallow and deep wells in well clusters for several hundred feet on both sides of the river. Groundwater in the study area was found to be migrating east-southeast towards the river, while on the opposite side of the river, the groundwater flow direction is generally northward towards the river.

Additional groundwater data were collected in 2005 to refine the information collected for the Phase 2 RI. Figure 2-6 is a potentiometric surface map for the shallow and intermediate zones at Site 6A. A vertical flow net was constructed using data from selected well clusters and the staff gauges, illustrating the flow to the river from both sides (Figure 2-7). Based on the interpretation of the data collected, any groundwater contamination that may reach the river is expected to discharge to the river and not migrate further south beyond the river.

In 1997, the Nature Conservancy – Long Island Chapter prepared several water table contour maps for the general Calverton area. These maps indicate that the groundwater flow direction within the Southern Area is generally to the east-southeast, towards the Peconic River. An overall groundwater flow gradient across the study area of approximately 0.0012 was calculated based on the water table contour maps. This overall flow gradient was in good agreement with site-specific groundwater flow gradients observed during the RFI.

The hydraulic characteristics of the upper glacial aquifer at the NWIRP were evaluated during the RFI through slug tests performed at several sites and the performance of a pumping test at Site 2. Based on the slug testing, the shallow portion of the upper glacial aquifer at NWIRP has an average hydraulic conductivity of about 111 ft/day, while the average hydraulic conductivity of the deeper sediments is approximately 36 ft/day. Pumping test results indicate an average horizontal hydraulic conductivity of 91 ft/day, vertical hydraulic conductivity of 8.5 ft/day, and specific yield of 0.07 for the upper glacial aquifer. These tests were all performed in and are representative of the uppermost portion of the upper glacial aquifer, above the clay layer found at a depth of approximately 60 feet. The porosity of the aquifer was assumed to be 0.25 (fine to medium sand).

The nearest drinking water well was located at a sportsman club in the Off-Site Southern Area near Connecticut Avenue and River Road. This well was shut down because contamination was detected in it. Another private well is located approximately 1 mile to the east of the facility in Calverton. The nearest pubic water supply well is located approximately 0.5 mile west of Site 6A.

2.4 NATURE AND EXTENT OF CONTAMINATION

2.4.1 Site 6A - Fuel Calibration Area

Site 6A was investigated during the RFI (HNUS, 1995a), EE/CA for Sites 2, 6A, 7, and 10B (TtNUS, 1998), Phase 2 RI and Supplemental Groundwater Investigation (TtNUS, 2001), Site 6A and Southern Area Supplemental Investigation (TtNUS, 2005), and a Site 6A Data Gap Investigation conducted in January 2006. Soil data were collected during the RFI, and data gap investigation, groundwater data were collected during all phases of investigation, with the exception of the data gap investigation and free product data were collected during the EE/CA and data gap investigation. The nature and extent of contamination at Site 6A is summarized below.

Soil

The results of the RFI indicated the presence of VOCs at relatively low to moderate concentrations in Site 6A soils. The RFI also revealed that petroleum free product remains at the site and has formed a smear zone in the vadose zone soil. The petroleum product was most likely derived from jet fuel used in the area. The VOCs and petroleum free product are estimated to be present in an area underneath and south of the concrete pad (see Figure 2-8). The size of the contaminated area based on RFI results was approximated to be 68,400 square feet. A RCRA hazardous waste characteristic evaluation [40 Code of Federal Regulations (CFR) 261] of site soils did not find that the soils would be classifiable as a characteristic hazardous waste. However, subsequent testing of the free product found polychlorinated biphenyls (PCBs) at concentrations greater than 50 mg/kg, which trigger Toxic Substances Control Program (TSCA) requirements (see free product discussion below). Polynuclear aromatic hydrocarbons (PAHs) and phthalates were detected at several locations throughout the site. However, only one PAH [benzo(a)pyrene at 0.11 mg/kg] at one location exceeded an NYSDEC soil action level. Lead was detected at most soil locations throughout the site, however not at concentrations that would be considered greater than background.

The January 2006 data gap investigation was performed to further define the extent of Site 6a petroleum and PCB contaminated soils. The results of this investigation more accurately defined the extent of Site 6a VOC and petroleum contamination, and reduced the area of contamination from 68,400 sf to 41,640 sf. Additionally, this investigation adequately defined the extent of PCB contaminated soil within the area of VOC and petroleum contaminated soil at Site 6A. A data summary report for the January 2006 Site 6a Data Gap Investigation is provided in Appendix A of this report.

Because the water table varies significantly based on weather conditions, a majority of the vadose zone soil may be saturated at various times during the year. It is likely that a smear zone of contamination is present in the soil over the range of the water table fluctations (i.e., between 5 and 7 feet bgs or approximately 2 feet). Using the smear zone thickness (2 feet) and area of VOC and petroleum contamination (41,640 square feet), the volume of contaminated soil is estimated to be 3,100 cubic yards. Within the area of Site 6A VOC and petroleum contaminated soils, the defined limits of PCB soil contamination indicate the presence of 410 of PCB contaminated soil. It is estimated that 15 cy of the 410 cy is classified as hazardous due to concentrations exceeding 50 mg/kg. The total mass of organic contamination in the soil was estimated to be 45,800 pounds. Detailed calculations are provided in Appendix B. The revised extent of soil contamination including data gap investigation results is presented on Figure 2-9. The extent of PCB contamination is presented on Figure 2-10.

Groundwater

Tables 2-1, 2-2, and 2-3 summarize the groundwater data collected in 1997, 2000, and 2005, respectively. NYSDEC groundwater quality standards are included in the tables for comparison purposes. The data sets include data from temporary and permanent monitoring wells and piezometers installed at depths less than 60 feet bgs. At 60 feet bgs, there is a silty clay unit that prevents deeper migration of contamination. Data from some vertical profile borings were found to be unreliable at depths greater than 60 feet bgs and were excluded from the data sets.

Chlorinated solvents and fuel-type (BTEX) VOCs have been consistently detected in Site 6A groundwater; however, concentrations have decreased significantly between 1994 and 2005. VOC concentrations in 1994 [1,1,1-trichloroethane (15,000 µg/L), 1,1-dichloroethane (5,800 µg/L), chloroethane (430 µg/L), toluene (330 µg/L), and xylenes (780 µg/L)] were approximately one to three orders of magnitude greater than concentrations detected in 2005 [1,1,1-trichloroethane (12 µg/L), 1,1-dichloroethane (29 µg/L), chloroethane (20 µg/L), toluene (3.8 µg/L), and xylenes (17 µg/L)]. Other chlorinated VOCs such as 1,2-dichloroethene (18.4 µg/L), tetrachloroethene (1.8 µg/L), and trichloroethene (4.04 µg/L) were detected in temporary wells sampled during the RFI in 1994; however, they have not been detected in permanent wells subsequently installed and sampled at the site.

Four semivolatile organic compounds (SVOCs), including 1,2-dichlorobenzene (9 µg/L), 2-methylnaphthalene (74 µg/L), 4-methylphenol (84 µg/L), and naphthalene (120 µg/L), were detected in Site 6A groundwater during the 1995 RFI. The maximum concentrations of these SVOCs exceeded NYSDEC groundwater quality criteria. Due to the magnitude of the VOC detections and the potential migration concerns associated with them, subsequent phases of investigation at Site 6A did not focus on these SVOCs. Therefore, current concentrations of these compounds in groundwater are not known but are expected to be lower than in 1995.

VOCs detected in groundwater samples collected in 1997, 2000, and 2005 at concentrations greater than NYSDEC groundwater quality criteria include 1,1,1-trichloroethane, 1,1-dichloroethane, 1,1-dichloroethene, benzene, chloroethane, ethylbenzene, toluene, and xylenes.

VOCs detected in groundwater samples collected in 1997, 2000, and 2005 at concentrations less than NYSDEC groundwater quality criteria include 1,1,2-trichlorotrifluoroethane (Freon 113), 1,2-dichlorobenzene, tetrachloroethane, and trans-1,2-dichloroethene. It should be noted that 1,2-dichlorobenzene was classified by EPA as an SVOC during previous sampling activities, but it is now classified as a VOC.

2-Butanone and acetone were detected in Site 6A groundwater during the 2005 sampling event. NYSDEC groundwater quality criteria are not available for these VOCs, but groundwater criteria from Technical and Administrative Guidance Memorandum (TAGM) 4046 (50 µg/L for both) are available for these compounds. Concentrations of both VOCs were less than the criteria, and they are not considered to be a concern for Site 6A groundwater.

The horizontal extent of Site 6A groundwater contamination based on the 2005 data set and known locations of free product is shown on Figure 2-11. The area of the groundwater contamination is approximately 100,000 square feet. The highest concentrations of contamination have typically been detected in the top 10 feet of the aquifer; however, contamination has been detected as deep as 52 feet bgs (FC-MW-02-I) or approximately 47 feet below the water table. The total thickness of the water table aquifer is approximately 57 feet at Site 6A. Using a contaminated aquifer thickness of 30 feet (approximately one-half of the total aquifer thickness), the area of contaminated groundwater (100,000 square feet), and a porosity of 0.25, the volume of contaminated groundwater is estimated to be 5.6 million gallons. The masses of chlorinated VOCs and fuel-related and other VOC contamination in the groundwater were estimated to be 3 pounds and 2 pounds, respectively. Detailed calculations are provided in Appendix B.

Free Product

Free product recovery was an ongoing Northrop Grumman operation at Site 6A until 1996. Approximately 1,900 gallons of petroleum product were recovered by the operation. Monitoring of free product thickness at Site 6A was performed in 1990, 1991, August 1995 through February 1996, November 1997, and March, April, and August 1998. Average product thickness across the site during the monitoring events ranged from trace amounts to approximately 1.0 foot. Generally, free product was only evident in Site 6A wells at appreciable amounts in the late fall and early winter months when the water table is at its seasonal low. Product thicknesses decreased to trace amounts in the spring.

Free product samples were collected and analyzed in 1998 for the EE/CA. One sample was collected from well FC-MW-02S and another was collected from a well located approximately 270 feet southeast of FC-MW-02S that was part of the former free product recovery system (Well 4). The free product sample from FC-MW-02S contained 1,1,1-trichloroethane (2,600,000 µg/kg), 1,1-dichloroethane (240,000 µg/kg), ethylbenzene (160,000 µg/kg), toluene (110,000 µg/kg), total xylenes (1,800,000 µg/kg), 2-methylnaphthalene (1,500,000 µg/kg), and naphthalene (760,000 µg/kg). These compounds are common solvents and constituents of aircraft fuel that would have been used at the site. The sample also contained low concentrations of 4,4'-DDD (68 µg/kg) and Aroclor-1260 (1.2 mg/kg). The free product sample from Well 4 (a Northrop Grumman well) contained 1,1,1-trichloroethane (65,000 µg/kg) and Aroclor-1260 (2,800 mg/kg). The source of the 4,4'-DDD in the product is unknown; however, it is likely that the source of the PCBs are transformers located in the vicinity of Well 4. PCB contamination of the free product was also observed during passive oil recovery actions in 1999 and 2000.

The free product samples were also analyzed for British Thermal Unit (BTU) content to determine if the product was suitable for recycling. The results were on the order of 21,000 BTUs per pound, indicating that the free product is suitable for recycling; however, the samples contained chlorinated compounds and PCBs at levels that may require any recovered free product to be handled as a RCRA/TSCA waste.

Trace amounts of free product were detected in well FC-MW-02S during the 2005 sampling event. In addition, a fuel-like odor was noticed in the purge water from well FC-MW-03S in 2005. These wells were sampled during March 2005, which is when product thicknesses are typically low. During the 2006 Data Gap Investigation soil borings were advanced using direct push technology (DPT) to more accurately define the extent of VOC and petroleum contaminated soils. The soil cuttings were also inspected for the presence of free product. Using the available information (see calculations in Appendix B), the free product remaining at Site 6A is approximately 45,800 pounds, or the equivalent of 6,100 gallons. Based on this estimate, about 31 percent of the free product (1,900 of 6,100 gallons) was removed during previous efforts and approximately 69 percent remains at the site. The remaining free product is mostly adsorbed on site soils in a smear zone and is not directly recoverable as a liquid.

2.4.2 Site 10B - Engine Test House

Site 10B was investigated during the Phase 2 RFI (CF Braun, 1998), EE/CA for Sites 2, 6A, 7, and 10B (TtNUS, 1998), and Phase 2 RI and Supplemental Groundwater Investigation (TtNUS, 2001). Soil data were collected during the RFI, groundwater data were collected during the RI, and free product data were collected for the EE/CA. The nature and extent of contamination at Site 10B is summarized below.

Soil

In 1997, 10 soil samples were collected at Site 10B from the soil/groundwater interface and analyzed for Total Petroleum Hydrocarbons (TPH) Diesel Range Organics (DRO) and Gasoline Range Organics (GRO). Two samples (ET-SB/TW-01A and ET-SB/TW03A, which are shown on Figure 2-8) contained TPH DRO at concentrations of 7,700 mg/kg and 8,500 mg/kg, respectively. NYSDEC does not have a criterion for TPH DRO; however, these concentrations indicate that there are relatively high amounts of organic (fuel-related) contamination in the soil at these locations and that free product may be present.

The area of fuel-related contamination appears to be localized to an area beneath and west of the concrete pad (see Figure 2-8). The size of the area is approximately 10,300 square feet. The water table varies significantly based on weather conditions, and various portions of the vadose zone soil may be saturated at various times during the year. It is likely that a smear zone of contamination is present in the soil over the range of the water table fluctations (i.e., between 8 and 10 feet bgs outside of the concrete and 4 to 6 feet bgs inside of the concrete). Using the smear zone thickness (2 feet) and area of contamination (10,300 square feet), the volume of contaminated soil is estimated to be 770 cubic yards. The total mass of organic contamination in the soil was estimated to be 18,000 pounds. Detailed calculations are provide in Appendix B.

Groundwater

Site 10B was last investigated in 1997 by installing and sampling temporary monitoring wells. Table 2-4 summarizes the groundwater data collected in 1997. NYSDEC groundwater quality standards are included in the table for comparison purposes.

Fuel-type VOCs were detected at concentrations greater than NYSDEC groundwater quality criteria in samples from the three temporary monitoring wells located just downgradient of the former UST (ET-TW-01A, ET-TW-02A, and ET-TW-03A) and in a sample from a temporary well located further downgradient of the former UST (ET-TW-07A). The locations of these temporary wells are shown on Figure 2-11. The fuel-type chemicals detected include benzene (1.95 µg/L), ethylbenzene (maximum detection of 1,084 µg/L), toluene (maximum concentration of 337 µg/L), and xylenes (maximum concentration of 196 µg/L). Other temporary monitoring wells at Site 10B did not exhibit evidence of significant fuel-type VOC contamination. Migration of low-concentration, fuel-type VOCs in groundwater much beyond the source area is not common because of biodegradation and other natural attenuation factors.

The estimated horizontal extent of fuel-type VOC contamination is shown on Figure 2-11 and consists of an area of approximately 25,200 square feet. It was assumed that the benzene concentration at ET-TW-07A had decreased to less than 1 µg/L by 2005 to determine the extent of contamination. The fuel-type VOC contamination was generally detected within the top 20 feet of the water table aquifer. Fuel-type contamination was also sporadically detected at low concentrations (less than 5 µg/L) at greater depths, but this contamination may be attributable to Site 6A. The total thickness of the water table aquifer is approximately 50 feet at Site 10B. Using a contaminated aquifer thickness of 20 feet, the area of fuel-type contaminated groundwater (25,200 square feet), and a porosity of 0.25, the volume of contaminated groundwater is estimated to be 943,000 gallons. The total mass of fuel-type contamination in the groundwater was estimated to be 0.8 pound. Detailed calculations are provided in Appendix B.

Free Product

Monitoring of free product thickness at Site 10B was performed from August 1995 through January 1996, and again in March, April, and August 1998. Even though TPH concentrations detected in soil samples collected at the soil/groundwater interface suggested that free product may be present, measurable free product was not observed during the 1995/1996 field activity and only a slight sheen was observed in two wells in March 1998. No product was able to be collected for analysis. Using the estimated mass of petroleum contamination in the soil and other available information (see calculations in Appendix B), the volume of petroleum product still remaining at Site 10B is approximately 18,000 pounds, or the equivalent of 2,500 gallons. The remaining free product is mostly adsorbed on site soils in a smear zone and is not directly recoverable as a liquid.

2.4.3 Southern Area (On Site)

The Southern Area is a general area of groundwater contamination located downgradient of Sites 6A and 10B. The area was investigated during the Phase 2 RI (TtNUS, 2001) and Site 6A and Southern Area Supplemental Investigation (TtNUS, 2005). Contamination, which is not continuous throughout this area, consists of chlorinated solvents and is believed to have resulted from either intermittent releases at Sites 6A and 10B or from potential overland migration through a series of ditches and ponds in the area. The Southern Area extends from Sites 6a and 10B to near the Peconic River. This CMS address only the on-site portion, which includes the area north of Grumman Boulevard (see Figure 2-12).

Chlorinated VOCs were detected in temporary wells within and downgradient of Site 10B at concentrations greater than NYSDEC groundwater quality criteria. The temporary well in which the highest concentrations of chlorinated VOCs were detected was ET-TW-05A (see Figure 2-11). Maximum concentrations of 1,1,1-trichloroethane (166 µg/L), 1,1-dichloroethene (188 µg/L), and chloroethane (138 µg/L) were detected in the temporary well at a depth of approximately 10 feet below the water table. Similar contaminants were also detected at concentrations exceeding NYSDEC groundwater quality criteria in temporary well ET-TW-15A, located approximately 30 feet southeast of ET-TW-05A, at depths of 30 and 50 feet below the water table. Some of these chlorinated VOCs were also detected at concentrations exceeding NYSDEC groundwater quality criteria in downgradient temporary wells ET-TW-07A, ET-TW-08A, and ET-TW-11A at depths between 10 and 50 feet below the water table.

Figure 2-12 shows the horizontal extent of the contaminant plume downgradient of Site 6A to the property boundary. The area of the plume is approximately 86 acres (3,730,000 square feet). The chlorinated VOC contamination was generally detected within the top 40 feet of the water table aquifer. At 60 feet bgs, there is a silty clay unit that would prevent deeper migration of contamination. Some fuel-related compounds were also detected in the On-Site Southern Area Plume, but these detections were generally very low. Using a contaminated aquifer thickness of 30 feet, the area of the plume (86 acres square feet), and a porosity of 0.25, the volume of contaminated groundwater is estimated to be 209 million gallons. The total masses of chlorinated VOC and other VOC contamination in the On-Site Southern Area Plume were estimated to be 68 pounds and 97 pounds, respectively (see Appendix B).

Other chlorinated VOCs such as bromomethane (353 µg/L), chlorobenzene (381 µg/L), chloroform (16 µg/L), methylene chloride (7 µg/L), and vinyl chloride were detected infrequently (1 out of 37 samples) at concentrations greater than NYSDEC groundwater quality criteria. Chloroform, methylene chloride, and vinyl chloride can be created through the degradation of other chlorinated VOCs, and chloroform and methylene chloride can also be found in chlorinated drinking water. These VOCs were not detected or were detected infrequently elsewhere at the facility. These results indicate that some of these VOCs may be present because of the migration (e.g., via groundwater or overland flow and re-infiltration) and degradation of chlorinated VOCs released from Site 6A, and the other VOCs may be present in the groundwater as a result of a minor release of these chemicals at Site 10B. These contaminants will be considered as part of the On-Site Southern Area Plume.

Freon 113 (1,1,2-trichlorotrifluorethane) was detected at a maximum concentration of 152 µg/L in two temporary monitoring wells located east of Site 10B (ET-TW-07A and ET-TW-08A). The Freon 113 was detected at depths between 10 and 30 feet below the water table. Other temporary monitoring wells at Site 10B did not contain Freon 113 at concentrations greater than groundwater criteria, indicating that the freon contamination is limited to the area of these two wells (see Figure 2-11). Freon 113 may have used at Site 6A to test fuel lines, and it was detected in soil at Site 6A during the Phase 2 RI and in groundwater in 1997 and 2005. It has also been detected in groundwater sporadically throughout the facility. Other VOCs such as 1,1,1-trichloroethane, 1,1-dichloroethane, 1,1-dichloroethene, and 1,2-dichloroethene, which have been attributed to Site 6A, were also detected in temporary wells ET-TW-07A and ET-TW-08A. Therefore, it is uncertain as to whether Site 6A was the original source of the Freon 113 or alternatively, there may have been a minor release of it at Site 10B in the open field around these wells. Freon 113 will be considered as part of the On-Site Southern Area Plume.

2.5 CONTAMINANT FATE AND TRANSPORT

This section contains information on various aspects of contaminant fate and transport and the chemical properties affecting contaminant migration at Site 6A, Site 10B, and Southern Area. The section also evaluates observed chemical contaminant trends and the potential for natural attenuation of the contaminants at the sites.

2.5.1 Chemical and Physical Properties Impacting Fate and Transport

Table 2-5 presents the physical and chemical properties of the contaminants detected at the sites. These properties can be used to determine the environmental mobility and fate of site contaminants. The properties of interest include the following:

- Specific gravity
- Vapor pressure
- Water solubility
- Octanol/water partition coefficient (K_{ow})
- Organic carbon partition coefficient (K_{oc})
- Henry's Law constant
- Mobility index (MI)

Specific Gravity

Specific gravity is the ratio of the weight of a given volume of pure chemical at a specified temperature to the weight of the same volume of water at a given temperature. Its primary use is to determine whether a chemical will have a tendency to float or sink in water if it is present as a pure chemical or at very high concentrations. Chemicals with a specific gravity greater than 1 will tend to sink, and chemicals with a specific gravity less than 1 will tend to float. The specific gravity of chemical mixtures will sink or float based on the average properties of the mixture. This parameter becomes important in discussions regarding the potential presence of free product in non-aqueous-phase liquids.

Of the chemicals detected at these sites, some monocyclic aromatics (benzene, ethylbenzene, toluene, and xylenes) have a specific gravity less than 1. Halogenated aliphatics (e.g., 1,1,1-trichloroethane) and PAHs (e.g., naphthalene) have a specific gravity greater than 1.

Vapor Pressure

Vapor pressure provides an indication of the rate at which a chemical volatilizes from both soil and water. It is of primary importance at environmental interfaces such as surface soil/air and surface water/air. Volatilization is not as important when evaluating contaminated groundwater and subsurface soils that are not exposed to the atmosphere. Vapor pressures for monocyclic aromatics and halogenated aliphatics are generally many times higher than vapor pressures for PAHs. Chemicals with higher vapor pressures are expected to enter the atmosphere much more readily than chemicals with lower vapor pressures. Volatilization is a significant loss process for VOCs in surface water or surface soil.

Water Solubility

The rate at which a chemical is leached from a waste source by infiltrating precipitation is proportional to its water solubility. More soluble chemicals are more readily leached than less soluble chemicals. VOCs are generally more soluble than other chemicals such as PAHs.

Octanol/Water Partition Coefficient

The K_{ow} is a measure of the equilibrium partitioning of chemicals between octanol and water. It is useful in characterizing the sorption of compounds by organic soils where experimental values are not available. Most VOCs are less likely to partition to free product then chemicals such as PAHs.

Organic Carbon Partition Coefficient

The K_{oc} indicates the tendency of a chemical to adhere to soil particles containing organic carbon. Chemicals with high K_{oc}s generally have low water solubilities and vice versa. This parameter may be used to infer the relative rates at which the more mobile chemicals (monocyclic aromatics and halogenated aliphatics) are transported in groundwater. VOCs are relatively mobile in the soil and groundwater, and PAHs are relatively immobile when compared to VOCs.

Henry's Law Constant

Both the vapor pressure and the water solubility are of use in determining volatilization rates from surface water bodies and from groundwater. The ratio of these two parameters (the Henry's Law constant) is used to calculate the equilibrium chemical concentrations in the vapor (air) phase versus the liquid (water) phase for the dilute solutions commonly encountered in environmental settings. In general, chemicals having a Henry's Law constant of less than $1x10^{-5}$ atm-m^3/mole should volatilize very little and be present only in minute amounts in the atmosphere or soil gas. For chemicals with a Henry's Law constant greater than $5x10^{-3}$ atm-m^3/mole, such as many of the monocyclic aromatics and halogenated aliphatics, volatilization and diffusion in soil gas could be significant.

Mobility Index

The MI is a quantitative assessment of mobility that uses water solubility (S), vapor pressure (VP), and the K_{oc} (Laskowski, 1983). It is defined as follows:

$$MI = \log ((S*VP)/K_{oc})$$

A scale to evaluate MI as presented by Ford and Gurba (1984) is as follows:

Relative MI	Mobility Description
> 5	extremely mobile
0 to 5	very mobile
-5 to 0	slightly mobile
-10 to -5	immobile
< -10	very immobile

The MIs of most monocyclic aromatics and halogenated aliphatics range from 0 to 5 indicating that these chemicals are very mobile. Lighter molecular weight PAHs, such as naphthalene, have MIs ranging from -5 to 0 and are considered slightly mobile.

2.5.2 Contaminant Transport Pathways

This section presents a brief overview of contaminant fate and transport issues at the sites. Based on the evaluation of existing conditions, the following potential contaminant transport pathways may have previously existed or currently exist at the sites:

- Leaching of soil contaminants to groundwater
- Migration of groundwater contaminants
- Migration of contaminants in surface water
- Volatilization from soil or groundwater

Leaching of Soil Contaminants to Groundwater

Contaminants that adhere to soil particles or have accumulated in soil pore spaces can leach and migrate vertically to the groundwater as a result of infiltration or precipitation. The rate and extent of this leaching are influenced by the depth of the water table, amount of precipitation, rate of infiltration, physical and chemical properties of the soil, and physical and chemical properties of the contaminant. Contaminants at Site 6A were spilled at the ground surface and migrated vertically to the groundwater table. Contaminants at Site 10B were either released by the same mechanism as at Site 6A or they leaked from the former UST just above the groundwater table.

Migration of Groundwater Contaminants

Contaminants can migrate with groundwater in either a dissolved phase or as an immiscible liquid (free product). Contaminant concentrations may be affected by one or more mechanisms during transport.

Volatilization or precipitation may physically transform contaminants. Contaminants may be chemically transformed through photolysis, hydrolysis, or oxidation/reduction. Contaminants may also be biologically transformed by biodegradation. Additionally, contaminants may accumulate in one or more media.

Organics leaching from soil into groundwater can migrate as dissolved constituents in groundwater. Three general processes govern the migration of dissolved constituents in groundwater: advection, dispersion, and retardation. Advection is a process by which solutes are carried by groundwater movement. Dispersion is a mixing of contaminated and uncontaminated water during advection. Retardation is a slowing of contaminant migration caused by the reaction of the solute with the particulate-type matter in the aquifer. The distribution of dissolved contaminants in the groundwater at Site 6A, Site 10B and the Southern Area indicate that the halogenated aliphatics are the most mobile contaminants and the PAHs are the least mobile.

A contaminant that is present in water at a concentration greater than its solubility concentration will form an immiscible liquid. Based on the specific gravity of the contaminant, it will either float or sink in the water. In the case of chlorinated solvents (e.g., 1,1,1-trichloroethane), the pure liquid solvents will typically sink in the water because they have higher specific gravities than water. For most petroleum compounds including jet fuel, the pure product will float. Mixtures of chlorinated solvents will either sink or float based on average properties.

Subsurface transport of the immiscible contaminants is governed by a set of factors different from those of dissolved contaminants. Movement of an immiscible liquid is controlled by entry conditions and flow conditions (Feenstra et al., 1995). Entry of an immiscible liquid to a subsurface system is primarily controlled by the capillary phenomena. These phenomena arise from the fact that an interfacial tension is present between two mutually immiscible liquids (contaminant and water or contaminant and air) in small pore spaces. Once in a subsurface system, the rate and direction of flow depend on the density and viscosity of the fluid, the pressure driving the fluid, the hydraulic conductivity of the formation, and the degree of saturation of the fluid in the formation (Feenstra et al., 1995). Fluids denser than water will sink, and fluids lighter than water will float. An immiscible liquid will flow faster where the fluid is already present in the formation. Contaminants from the immiscible liquids may dissolve into groundwater, volatilize from the groundwater to ground air, evaporate directly into ground air, or sorb from groundwater to solid surfaces.

Significant amounts of free product were detected at the soil/groundwater interface at Site 6A. Approximately 1,900 gallons of the product were recovered through various recovery methods. The free product contained a mixture of monocyclic aromatics, halogenated aliphatics, and PAHs. The specific gravity of the resulting mixture must have been less than 1 because the product was detected at the soil/groundwater interface and not at depth. Some free floating product remains at Site 6a, but the majority appears to be adsorbed onto the soils.

Some free floating product was detected at the soil/groundwater interface at Site 10B. The product released at Site 10B is probably from the former UST and fuel-related. No product was detected at depth at this site.

Migration of Contaminants in Surface Water

Contaminants leaching from soils to surface water can migrate as dissolved constituents in surface water in the direction of surface water flow. Three general processes govern the migration of dissolved contaminants caused by the flow of water: movement caused by the flow of surface water, movement caused by the irregular mixing of water, and chemical mechanisms occurring during the movement of surface water. Sediment particles can disassociate from the sediment into surface water and migrate by one of the aforementioned methods.

A drainage swale and culvert from Site 6A runs adjacent to and hydraulically upgradient of Site 10B. From the late 1980s to the early 1990s, groundwater from Site 6A that contained chlorinated VOCs was discharged into this drainage swale and culvert. As a result, the presence of chlorinated VOC-contaminated groundwater at Site 10B and the Southern Area can probably be attributed to overland transport and re-infiltration of Site 6A groundwater through the drainage swale, culvert, and ponds around Site 10B.

Volatilization from Soil or Groundwater

Chemicals in soil can migrate into ambient air either as vapors or by adhering to particulate matter (dusts). Chemicals that have a significant volatility are likely to enter ambient air as vapors. These chemicals are generally considered to be compounds with Henry's Law Constants greater than 1.0×10^{-5} atm-m^3/mole and molecular weights less than 200 (i.e., many of the monocyclic aromatics and halogenated aliphatics). Chemicals with lower Henry's Law Constants and higher molecular weights are more likely to enter ambient air on particulate matter carried by winds.

Because VOCs are typically very mobile, they may leach to groundwater (as discussed above) or volatilize into ambient air. VOC vapors in groundwater or subsurface soil may migrate through the overlying soil layers and into ambient air. Studies have shown that the vapors can move either horizontally or vertically in the subsurface. The vapors may also enter buildings through cracks in building foundations or walls. Upon entering ambient air, the vapors are not expected to persist for long periods of time because their half-lives in the atmosphere are typically measured in hours or a few days. Vapors may also be released to ambient air from soil or groundwater during excavation activities.

2.5.3 Chemical Fate and Persistence

Several transformation mechanisms affect chemical persistence, such as hydrolysis, biodegradation, photolysis, and oxidation/reduction reactions. The following classes of compounds were detected at Site 6A, Site 10B, and the Southern Area:

- Monocyclic aromatics (BTEX)
- Halogenated aliphatics (solvents)
- PCBs/PAHs

Monocyclic Aromatics

Monocyclic aromatic compounds such as benzene and chlorobenzene are not considered to be persistent in the environment. Monocyclic aromatics are subject to degradation via the action of both soil and aquatic microorganisms. The biodegradation of these compounds in the soil matrix is dependent on the abundance of microflora, macronutrient availability, soil reaction (pH), temperature, etc.

Although these compounds are amenable to microbial degradation, it is not anticipated that degradation under current site conditions will occur at an appreciable rate. In the event that these compounds discharge to surface water bodies, volatilization and biodegradation may occur relatively rapidly. For example, a reported first-order biodegradation rate constant for benzene is 0.11 day^{-1} in aquatic systems (Lyman et al., 1990). This corresponds to an aquatic half-life of approximately 6 days. Other monocyclic aromatics are subject to similar degradation processes in aquatic environments (EPA, 1982).

Chlorinated monocyclic aromatics such as chlorobenzene are not expected to be as susceptible to microbial degradation. For example, a reported first-order biodegradation rate constant for chlorobenzene is 0.0045 day^{-1} in aquatic systems (Lyman et al., 1990), which corresponds to an aquatic half-life of approximately 150 days.

Additional environmental degradation processes, such as hydrolysis and photolysis, are considered to be insignificant fate mechanisms for monocyclic aromatics in aquatic systems (EPA, 1982). However, some monocyclic aromatics such as benzene and toluene have been shown to undergo clay, mineral, and soil-catalyzed oxidation (Dragun, 1988).

Halogenated Aliphatics

In general, halogenated aliphatic hydrocarbons are subject to abiotic dehydrohalogenation. This process is an elimination reaction that results in the formation of an ethene from a saturated halogenated compound. Research indicates that microbial degradation of highly chlorinated ethanes is a relatively slow process. Hydrolysis, photolysis, and oxidation are generally not considered to be significant fate processes for the chlorinated ethanes.

Under certain conditions, volatilization is a significant fate process for these compounds. Volatilization is only significant at the air/soil or air/water interface. Compounds such as chloroform and methylene chloride volatilize rapidly to the atmosphere from soil or surface water due to low soil adsorption. Adsorption should not be considered as an important fate for these types of compounds when compared to more hydrophobic compounds.

Photolysis is not considered to be a relevant degradation mechanism for this class of compounds (EPA, 1982). Limited hydrolysis of saturated aliphatics (i.e., alkanes) may occur, but it does not appear to be a significant degradation mechanism for unsaturated species (i.e., alkenes) (EPA, 1982).

PCBs/PAHs

PCBs and PAHs have very low solubilities, vapor pressures, and Henry's Law constants and high K_{oc}s and K_{ow}s. The low molecular weight PAHs (e.g., 2-methylnaphthalene and naphthalene) may volatilize from surface waters, and the high molecular weight PAHs [e.g., benzo(a)pyrene, benzo(a)anthracene, chrysene, etc.] and PCBs are less likely to volatilize. PCBs and PAHs in soil are much more likely to bind to soil and be transported via mass transport mechanisms than to go into solution. PAHs are subject to degradation via aerobic bacteria but may be relatively persistent in the absence of suitable microbial populations or macronutrients such as phosphorus and nitrogen. PCBs are generally resistant to biodegradation.

Landspreading applications have indicated that PAHs are highly amenable to microbial degradation in soil. The rate of degradation is influenced by temperature, pH, oxygen concentrations, initial chemical concentrations, and moisture. Photolysis, hydrolysis, and oxidation are not important fate processes for the degradation of PAHs in soil (ATSDR, 1997).

Observed Chemical Contaminant Trends

Soluble contaminant concentrations detected in groundwater in the source area at Site 6A have decreased significantly over the past 10 years; however, soil contamination and free product are still present above the water table at Site 6A. The decreases in concentrations can be attributed to natural attenuation processes. However, the remaining soil contamination and free product may continue to act as a source of contamination to the groundwater. The contaminants with the highest solubilities (monocyclic aromatics and halogenated aliphatics) and lowest K_{oc}s have the highest potential to migrate from the soil to groundwater and also have the highest groundwater transport potential.

Overland transport and re-infiltration of contaminated Site 6A groundwater may no longer be a continuing source of contamination to areas downgradient of Site 6A. The free product recovery system has been shut down. Groundwater contamination may continue to increase in extent as a result of the previous releases and dissolved contaminant transport, but the contaminant concentrations should not increase. Flowable free product at the site is significantly reduced.

Only one round of groundwater and soil data was collected at Site 10B; therefore, it is not possible to determine contaminant trends for the site. It is suspected that some fuel-type soil contamination and trace amounts of free product related to the former UST are still present above the water table and may continue to act as a source of contamination. Migration of low-concentration, fuel-type VOCs in groundwater much beyond the source area is not common because of biodegradation and other natural attenuation factors. Therefore, it is unlikely that the extent of groundwater contamination at Site 10B will continue to increase.

Natural Attenuation Evaluation

An evaluation of natural attenuation processes on contaminant concentrations in Site 6A groundwater was completed during the Phase 2 RI (TtNUS, 2001). The evaluation was conducted using data collected through 2000, and the results of the evaluation are as follows:

- BIOSCREEN and BIOCHLOR models were used to complete fate and transport modeling. BIOSCREEN was used to model concentrations of ethylbenzene, toluene, xylenes, and Freon 113, and BIOCHLOR and BIOSCREEN were used to model concentrations of 1,1,1-trichloroethane. It was estimated that the contaminants were released via spills at the ground surface from the mid 1970s to the mid 1980s.

- Fuel-type chemicals such as ethylbenzene, toluene, and xylenes generally degrade in groundwater through aerobic biodegradation processes, and carbon dioxide and water are formed. Chlorinated solvents generally degrade in groundwater through anaerobic biodegradation processes. The primary anaerobic degradation pathway for 1,1,1-trichloroethane is as follows: 1,1-dichloroethane, chloroethane, ethane, and methane/carbon dioxide/water/chloride. Chloroethane, methane, and ethane are also readily biologically degraded under aerobic conditions to form carbon dioxide and water.

- The modeling results showed that the contaminant plume associated with Site 6A should remain stable, and it is not expected to migrate more than 1,500 feet downgradient. Therefore, contamination originating from Site 6A and migrating horizontally only through the water table aquifer should not reach the Peconic River. The presence of chlorinated VOC-contaminated groundwater at Site 10B and downgradient of Site 10B (Southern Area) can be attributed to the Site 6A product recovery system that discharged contaminated groundwater to the drainage swale, culvert, and ponds around Site 10B and resulted in overland transport and re-infiltration of the contaminated groundwater. The groundwater contamination downgradient of Site 10B (On-Site Southern Area Plume) has the potential to reach the Peconic River.

- The estimated source area mass of ethylbenzene in 1975 was 270 pounds, and the groundwater concentration was 15,200 µg/L. The estimated source area mass in 2000 was 1.1 pounds and the groundwater concentration was 58 µg/L. Modeling predicted that ethylbenzene concentrations throughout the Site 6A plume would decrease at less than 5 µg/L within 12 years by natural attenuation processes. If 90 percent of the source mass was removed, the groundwater concentrations would be less than 5 µg/L within 3 years. The maximum groundwater concentration of ethylbenzene detected in 2005 was 1.1 µg/L, which indicates that natural attenuation processes appear to be occurring as estimated.

- The estimated source area mass of toluene in 1975 was 88 pounds, and the groundwater concentration was 1,200 µg/L. The estimated source area mass in 2000 was 1.1 pounds and the groundwater concentration was 58 µg/L. Modeling predicted that toluene concentrations throughout the Site 6A plume would decrease to less than 5 µg/L within 15 years by natural attenuation processes. If 90 percent of the source mass was removed, groundwater concentrations were predicted to be less than 5 µg/L within 9 years. The maximum groundwater concentration of toluene detected in 2005 was 3.8 µg/L, which indicates that natural attenuation processes appear to be more effective than the model predicted.

- The estimated source area mass of xylenes in 1975 was 310 pounds, and the groundwater concentration was 4,000 µg/L. The estimated source area mass in 2000 was 85 pounds and the groundwater concentration was 1,100 µg/L. Modeling predicted that xylene concentrations throughout the Site 6A plume would decrease to less than 5 µg/L within 105 years by natural attenuation processes. If 90 percent of the source mass was removed, groundwater concentrations were predicted to be less than 5 µg/L within 12 years. The maximum groundwater concentration of xylenes detected in 2005 was 17 µg/L, which indicates that natural attenuation processes appear to be more effective than the model predicted.

- The estimated source area mass of Freon 113 in 1975 was 33 pounds, and the groundwater concentration was 500 µg/L. The estimated source area mass in 2000 was 7.3 pounds and the groundwater concentration was 111 µg/L. Modeling predicts that Freon concentrations throughout the Site 6A plume would decrease to less than 5 µg/L within 50 years by natural attenuation processes. If 90 percent of the source mass was removed in 2000, groundwater concentrations were predicted to be less than 5 µg/L within 6 years. The maximum groundwater concentration of Freon 113 detected in 2005 was 1.1 µg/L, which indicates that natural attenuation processes appear to be more effective than the model predicted.

- The estimated source area mass of 1,1,1-trichloroethane in 1975 was 990 pounds, and the groundwater concentration was 35,000 µg/L. The estimated source area mass in 2000 was 60 pounds and the groundwater concentration was 2,113 µg/L. Modeling predicted that 1,1,1-trichloroethane concentrations throughout the Site 6A plume would decrease to less than 5 µg/L within 43 years by natural attenuation processes. If 90 percent of the source mass was removed, groundwater concentrations would be less than 5 µg/L within 10 years. The maximum groundwater concentration of 1,1,1-trichloroethane detected in 2005 was 12 µg/L, which indicates that natural attenuation processes appear to be more effective than the model predicted.

2.6 HUMAN HEALTH RISK ASSESSMENT

A baseline human health risk assessment was completed for Site 6A during the RFI (HNUS, 1995a). A baseline risk assessment was not completed for Site 10B; however, because the contaminants released at both sites are similar the risks associated with exposure to Site 10B media would probably be similar to those at Site 6A. Some of the contaminated soil associated with the former UST at Site 10B was previously remediated, which may have reduced the risks associated with Site 10B. The contaminants detected in the groundwater of the On-site Southern Area Plume are similar to those found in the groundwater at Sites 6A and 10B. The risks from exposure to the groundwater in the On-Site Southern Area Plume would be comparable but lower than the risks from exposure to groundwater at Site 6A.

The following information was taken from the Site 6A human health risk assessment in the RFI. A summary of the calculated risks is presented in Table 2-6.

- Only the risk estimate calculated for benzo(a)pyrene in soil individually exceeds 1×10^{-6}. This risk is associated with surface soil because subsurface soil samples were not analyzed for SVOCs. In contrast, cancer risk estimates developed for chloroethane (1.18×10^{-5}) and 1,1-dichloroethene (2.4×10^{-5}) in groundwater exceeded 1×10^{-5}.

- The hazard indices (HIs) developed for adult and child receptors assuming a future residential land use scenario were 8.9 and 23.6, respectively. These results indicate that there is a potential for adverse noncarcinogenic health effects under the conditions specified in the exposure assessment. However, the majority of the risk is attributable to hypothetical residential exposure to chemicals detected in groundwater. HIs developed for contaminants in soils do not exceed unity, an indication that adverse noncarcinogenic health effects are not anticipated for soil exposure pathways evaluated in the baseline risk assessment. In contrast, hazard quotients developed for the following chemicals in groundwater do exceed a value of 1 individually when adult and/or child receptors are evaluated:

1,1,1-Trichloroethane	4-Methylphenol
1,1-Dichloroethane	1,1-Dichloroethene

- The Integrated Exposure Uptake Biokinetic (IEUBK) Lead Model was used to characterize potential effects associated with exposure to media containing lead. The model considers exposures to lead in air, food, soil/dust, and drinking water and estimates blood lead levels in receptors aged 0 to 6 years. The results are summarized in a probability histograph, with the population experiencing blood-lead levels greater than 10 microgram per deciliter (µg/dL) identified as a percentage. The IUEBK Model results for Site 6A indicate that 2.39 percent of exposed children will experience blood-lead concentrations greater than 10 µg/dL. Under default and background conditions, only 0.03 percent of the exposed receptors will exceed this benchmark blood-lead level. The groundwater at the site is solely responsible for the increase, as all other input parameters are either background or default values.

- <u>Qualitative Risk Assessment</u>: The focus of the qualitative risk assessment was to identify regulations (ARARs) and other standards (TBCs) that are exceeded by measured site contaminant levels. The standards presented are those that have been developed for the protection of human health. Other criteria, developed for the protection of the environment and ecological receptors, are not considered. Discussion of the qualitative risk assessment is presented on a medium-specific basis.

- <u>Soil</u>: Although no federal standards are generally available for evaluating soils in a qualitative manner, the State of New York has adopted soil criteria that are designed to be protective of the environment (i.e., groundwater). The criteria are identified in TAGM Number 4046, Determination of Soil Cleanup Objectives and Cleanup Levels, as revised January 26, 1994. As identified in Table 2-7, at least one reported result for xylenes, benzo(a)pyrene, isophorone, 2-methylnaphthalene,

naphthalene, nitrobenzene, 2-nitrophenol, and phenol exceeds its TAGM standard. The TAGM cleanup goal exceedences are noted to be primarily associated with sampling location SS04/SB04, although additional exceedences are noted for SB05.

- Groundwater: Analytical results for Site 6A groundwater were compared to federal and State Maximum Contaminant Levels (MCLs) and State groundwater quality standards, and results are presented in Table 2-8. Concentrations of chlorinated and fuel-related VOCs were greater than federal or State MCLs and/or State groundwater quality standards in at least one sample for all detected chemicals. Additionally, 1,2-dichlorobenzene, 4-methylphenol, naphthalene, and 2-methylnaphthalene concentrations exceeded respective standards in one sample. Monitoring well FC-MW-2S had the highest reported concentrations of contaminants and the highest number of chemicals that exceeded the standards.

- Risk Assessment Conclusions: The results of the Site 6A risk assessment showed that no adverse risks would be expected for current workers. However, under a hypothetical future residential land use scenario, adverse risks to human health would be expected from both direct contact with soils (surface) and ingestion of groundwater. The HI exceeds 1.0 only for domestic use of groundwater. Calculated incremental cancer risks (ICRs) are approximately 8.1×10^{-6} and 2.5×10^{-3} for soil and groundwater, respectively. The primary COCs for future residents include chlorinated and nonchlorinated solvents, PAHs, substituted benzene compounds (e.g., 1,2-dichlorobenzene), phenolics, and naphthalene compounds.

A qualitative evaluation of the Site 10B and On-Site Southern Area plume groundwater data were completed to determine potential risks associated with exposure to the groundwater.

- Groundwater: Analytical results for Site 10B groundwater were compared to federal and State MCLs and State groundwater quality standards, and the results are presented in Table 2-9. Concentrations of chlorinated and fuel-related VOCs were greater than federal or State MCLs and/or State groundwater quality standards in at least one sample for all detected chemicals. Additionally, 1,1,2-trichlorotrifluorethane, bromomethane, chlorobenzene, chloroform, methylene chloride, and vinyl chloride concentrations exceeded respective standards. Maximum concentrations were detected in various temporary monitoring wells including ET-TW-01A, ET-TW-02A, ET-TW-03A, ET-TW-05A, ET-TW-07A, and ET-TW-15A.

2.7 CONTAMINANTS OF CONCERN

The existing Site 6A, Site 10B, and On-Site Southern Area Plume data, which are presented above, were reviewed to determine the COCs that should be carried forward and evaluated in the CMS. The COCs were selected based on the following criteria:

- Detectable amounts of free product that could act as a continuing source of contamination were found at the site.

- Soil contaminant concentration exceeds TAGM 4046 cleanup level (see Table 2-7).

- Groundwater contaminant concentration exceeds federal or State of New York standards or guidance (MCL, groundwater quality standard, groundwater effluent standard, or TAGM 4046) (see Tables 2-8 and 2-9).

- Contaminant concentration results in unacceptable risks to human receptors (i.e., carcinogenic risk greater than $1x10^{-6}$ and noncarcinogenic risk greater than 1).

2.7.1 <u>Site 6A</u>

Soil

The following contaminants were identified as COCs for Site 6A soil:

- Free product (fuel-related, chlorinated solvents, and PCBs)
- PCBs
- Total xylenes
- Benzo(a)pyrene
- Isophorone
- 2-Methylnaphthalene
- Naphthalene
- Nitrobenzene
- 2-Nitrophenol
- Phenol

Groundwater

The following contaminants were identified as COCs for Site 6A groundwater:

- 1,1,1-Trichloroethane
- 1,2-Dichlorobenzene
- 1,1-Dichloroethane
- 1,1-Dichloroethene
- Benzene
- Chloroethane
- Ethylbenzene
- Toluene
- Total xylenes
- 2-Methylnaphthalene
- 4-Methylphenol
- Naphthalene

2.7.2 Site 10B

Soil

The following contaminants were identified as COCs for Site 10B soil:

- Fuel-related contamination (soil and free product)

Groundwater

The following contaminants were identified as COCs for Site 10B groundwater in the source area:

- Benzene
- Ethylbenzene
- Toluene
- Total xylenes

2.7.3 On-Site Southern Area

The following contaminants were identified as COCs for the On-Site Southern Area Plume:

- 1,1,1-Trichloroethane
- 1,1,2-Trichlorotrifluoroethane (Freon 113)
- 1,1-Dichloroethane
- 1,1-Dichloroethene
- Bromomethane
- Chlorobenzene
- Chloroethane
- Chloroform
- Methylene chloride
- Vinyl chloride

TABLE 2-1

1997 GROUNDWATER DATA SUMMARY
SITE 6A - FUEL CALIBRATION AREA, SHALLOW WELLS
NWIRP CALVERTON, NEW YORK

Parameter	New York State GW Quality Standard (1)	Frequency of Detection	Min	Max	Range of Detections	Sample with Maximum Detection	Average of Positive Detections
1,1,1-Trichloroethane	5	5/30	0.62	19.79	0.62 - 19.79	FCGW0730	7.606
1,1,2-Trichlorotrifluoroethane	5	2/30	0.67	0.8	0.67 - 0.8	FCGW0630	0.735
1,1-Dichloroethene	5	4/30	0.95	1.4	0.95 - 1.4	FCGW0650	1.17
Benzene	1	2/30	37.4	43.9	37.4 - 43.9	FCGW0528	40.65
Ethylbenzene	5	2/30	8	20.3	8 - 20.3	FCGW0513	14.15
Toluene	5	2/30	10.7	33.9	10.7 - 33.9	FCGW0528	22.3
Total Xylenes	5	2/30	93.8	133.3	93.8 - 133.3	FCGW0513	113.55
Trans-1,2-dichloroethene	5	2/30	3.1	3.37	3.1 - 3.37	FCGW0630	3.235

GW - Groundwater
Min - Minimum
Max - Maximum
1 - 6 NYCRR Part 703, Surface Water and Groundwater Quality Standards and Groundwater Effluent Limitations, NYSDEC, Section 703.5, Table 1.
Shading indicates parameter concentration exceeds the New York State GW Quality Standard.

TABLE 2-2

2000 GROUNDWATER DATA SUMMARY
SITE 6A - FUEL CALIBRATION AREA, SHALLOW WELLS
NWIRP CALVERTON, NEW YORK

Parameter	New York State GW Quality Standard (1)	Frequency of Detection	Min	Max	Range of Detections	Sample with Maximum Detection	Average of Positive Detections
1,1,1-Trichloroethane	5	3/5	1.7	2000	1.7 - 2000	FC-GW02S-11-6-00-REP	1300.6
1,1-Dichloroethane	5	3/5	2.6	3400	2.6 - 3400	FC-GW02S-11-6-00-REP	2234.2
1,1-Dichloroethene	5	2/5	25	30	25 - 30	FC-GW02S-11-6-00-REP	27.5
Ethylbenzene	5	2/5	29	46	29 - 46	FC-GW02S-11.6-00	37.5
Toluene	5	2/5	110	140	110 - 140	FC-GW02S-11.6-00	125
Total Xylenes	5	2/5	330	510	330 - 510	FC-GW02S-11.6-00	420
Biochemical Oxygen Demand	NA	2/3	3600	23000	3600 - 23000	FC-GW02S-11.6-00	13300
Carbon Dioxide	NA	1/3	4300	4300	4300	FC-GW01S-00	4300
Chemical Oxygen Demand	NA	2/3	15200	84100	15200 - 84100	FC-GW02S-11.6-00	49650
Chloride	NA	2/3	2200	2300	2200 - 2300	FC-GW02S-11.6-00	2250
Iron [Filtered]	NA	2/3	7740	12100	7740 - 12100	FC-GW02S-11.6-00	9920
Manganese [Filtered]	NA	2/3	50	202	50 - 202	FC-GW01S-00	126
Methane	NA	3/3	62	2600	62 - 2600	FC-GW01S-00	1184
Nitrate	NA	1/3	140	140	140	FC-GW01S-00	140
Sulfate	NA	2/3	2000	4000	2000 - 4000	FC-GW01S-00	3000
Sulfide	NA	1/3	3000	3000	3000	FC-GW02S-11.6-00	3000
Total Organic Carbon	NA	2/3	1300	7800	1300 - 7800	FC-GW01S-00	4550

GW - Groundwater
Min - Minimum
Max - Maximum
NA - Not Available
1 - 6 NYCRR Part 703, Surface Water and Groundwater Quality Standards and Groundwater Effluent Limitations, NYSDEC, Section 703.5, Table 1.
Shading indicates parameter concentration exceeds the New York State GW Quality Standard.

TABLE 2-3

2005 GROUNDWATER DATA SUMMARY
SITE 6A - FUEL CALIBRATION AREA, SHALLOW WELLS
NWIRP CALVERTON, NEW YORK

Parameter	New York State GW Quality Standard [1]	Frequency of Detection	Min	Max	Range of Detections	Sample with Maximum Detection	Average of Positive Detections
1,1,1-Trichloroethane	5	1/19	12	12	12	FC-MW-02S	12
1,1,2-Trichlorotrifluoroethane	5	1/19	1.1	1.1	1.1	FC-MW-05I	1.1
1,1-Dichloroethane	5	2/19	1.5	29	1.5 - 29	FC-MW-02S	15.3
1,1-Dichloroethene	5	2/19	1.1	1.5	1.1 - 1.5	FC-MW-04S	1.3
1,2-Dichlorobenzene	3	1/19	0.58	0.58	0.58	FC-MW-02S	0.58
2-Butanone	50[2]	1/19	13	13	13	FC-PZ-104D2	13
Acetone	50	1/19	6.2	6.2	6.2	FC-MW-02S	6.2
Chloroethane	5	1/19	20	20	20	FC-MW-02S	20
Ethylbenzene	5	1/19	1.1	1.1	1.1	FC-MW-02S	1.1
Tetrachloroethene	5	1/19	0.23	0.23	0.23	FC-PZ-104D	0.23
Toluene	5	1/19	3.8	3.8	3.8	FC-MW-02S	3.8
Total Xylenes	5	1/19	17	17	17	FC-MW-02S	17

GW - Groundwater
Min - Minimum
Max - Maximum
1 - 6 NYCRR Part 703, Surface Water and Groundwater Quality Standards and Groundwater Effluent Limitations, NYSDEC, Section 703.5, Table 1.
Shading indicates parameter concentration exceeds the New York State GW Quality Standard.
2 - TAGM 4046

TABLE 2-4

1997 GROUNDWATER DATA SUMMARY
SITE 10B - ENGINE TEST HOUSE AND SOUTHERN AREA, SHALLOW WELLS
NWIRP CALVERTON, NEW YORK

Parameter	New York State GW Quality Standard (1)	Frequency of Detection	Min	Max	Range of Detections	Sample with Maximum Detection	Average of Positive Detections
1,1,1-Trichloroethane	5	8/37	0.62	165.5	0.62 - 165.5	ETGW0526	32.13
1,1,2-Trichlorotrifluoroethane	5	4/37	32.91	151.8	32.91 - 151.8	ETGW0730	90.98
1,1-Dichloroethane	5	3/37	5.35	49.21	5.35 - 49.21	ETGW1546	20.75
1,1-Dichloroethene	5	6/37	1.11	187.7	1.11 - 187.7	ETGW0526	37.43
Benzene	1	1/37	1.95	1.95	1.95	ETGW0730	1.95
Bromodichloromethane	5	1/37	4.1	4.1	4.1	ETGW0511	4.1
Bromomethane	5	1/37	353	353	353	ETGW0311	353
Chlorobenzene	5	1/37	381	381	381	ETGW0111	381
Chloroethane	5	2/37	45	137.9	45 - 137.9	ETGW0511	91.45
Chloroform	7	1/37	15.25	15.25	15.25	ETGW0226	15.25
Dichlorodifluoromethane	5	1/37	0.82	0.82	0.82	ETGW1546	0.82
Ethylbenzene	5	5/37	8.65	1084	8.65 - 1084	ETGW0311	262.76
Methylene Chloride	5	1/37	7	7	7	ETGW0511	7
Toluene	5	6/37	8.6	337	8.6 - 337	ETGW0126	141.15
Total Xylenes	5	4/37	39	195.5	39 - 195.5	ETGW0326	103.5
Vinyl Chloride	2	1/37	59.8	59.8	59.8	ETGW0730	59.8

GW - Groundwater
Min - Minimum
Max - Maximum
1 - 6 NYCRR Part 703, Surface Water and Groundwater Quality Standards and Groundwater Effluent Limitations, NYSDEC, Section 703.5, Table 1.
Shading indicates parameter concentration exceeds the New York State GW Quality Standard.

ETGW01, 02, 03, and 12 are directly associated with former UST.
Other samples are more characteristic of On-Site Southern Area Plume groundwater.

TABLE 2-5

ENVIRONMENTAL FATE AND TRANSPORT PARAMETERS FOR ORGANIC CHEMICALS
SITE 6A - FUEL CALIBRATION AREA, SITE 10B - ENGINE TEST HOUSE, AND ON-SITE SOUTHERN AREA PLUME
NWIRP, CALVERTON, NEW YORK

Chemical	Specific Gravity (@ 20/4°C)[1]	Vapor Pressure (mm Hg @ 20°C)[1]	Solubility (mg/L @ 20°C)[1]	Octanol/Water Partition Coefficient[1]	Organic Carbon Partition Coefficient[2]	Henry's Law Constant (atm-m^3/mole)[1]	Bioconcentration Factor (mg/L/mg/kg)[2]	Mobility Index log((solubility*VP)/K_{oc})
MONOCYCLIC AROMATICS								
1,2-Dichlorobenzene	1.3059	1.36E+00	1.56E+02	2.40E+03	6.17E+02	1.50E-03	2.30E+02	-4.64E-01
4-Methylphenol	1.0178	1.1E-1 (25°C)	2.4E+4 (25°C)	8.32E+01	9.0E-1[7]	3.92E-07	1.7E+1(6)	3.47E+00
Benzene	0.8765	9.50E+01	1.75E+03	1.35E+02	5.89E+01	5.55E-03	3.70E+01	3.45E+00
Chlorobenzene	1.11	1.18E+01	4.72E+02[3]	7.24E+02[3]	2.24E+02[3]	2.43E-03[3]	7.9E+01[5]	1.40E+00
Ethylbenzene	0.867	1E+1 (25.9°C)	1.52E+02	1.41E+03	3.63E+02[4]	8.043E-3 (25°C)	4.70E+02	6.22E-01
Toluene	0.8669	2.8E+1 (25°C)	5.15E+02	4.90E+02	1.82E+02 [4]	5.92E-3 (25°C)	1.48E+02	1.90E+00
Xylenes (Total)	0.86104-0.8801	1E+1 (27.3-32.1°C)	1.6E+2-1.75E+2[5]	5.89E+2-1.58E+3	3.63E+02-4.07E+02[4]	4.184E-3-6.662E-3 (25°C)	7.5E+1-1.59E+2[6]	6.44E-01-6.33E-01
HALOGENATED ALIPHATICS								
1,1,1-Trichloroethane	1.339	1.00E+02	4.40E+03	2.95E+02	1.10E+02[4]	4.08E-3 (25°C)	8.10E+01	3.60E+00
1,1,2-Trichloroethane	1.4397	2.50E+01	4.42E+02	1.12E+02	5.01E+01	9.13E-04	1.90E+01	2.34E+00
1,1,2-Trichlorotrifluorethane	1.56	3.62E+02	1.70E+02	1.45E+03	3.89E+02	5.26E-01	5.40E+01	2.20E+00
1,1-Dichloroethane	1.1757	2.34E+2 (25°C)	5.50E+03	1.67E+01	3.13E+01[4]	5.871E-3 (25°C)	1.90E+01	4.61E+00
1,1-Dichloroethene	1.218	5.91E+2 (25°C)	2.1E+2 (25°C)	3.02E+01	5.89E+01[4]	2.286E-2 (25°C)	5.30E+01	3.32E+00
1,2-Dichloroethane	1.2351	7.90E+01	8.52E+02	2.95E+01	1.74E+01	9.79E-04	8.10E+00	3.59E+00
Bromomethane	1.73 (0/0°C)	1.824E+3 (25°C)	9.00E+02	1.10E+00	2.10E+00	6.24E-03	4.70E+00	5.89E+00
Chloroethane	0.92 (0/4°C)	1.00E+03	5.74E+03	1.54E+00	1.52E+00	8.48E-3 (25°C)	6.7E-01-8.6E-01	6.58E+00
Chloroform	1.4832	1.60E+02	9.3E+3 (25°C)	9.33E+01	3.98E+01[4]	3.39E-3 (25°C)	2.60E+01	4.57E+00
cis-1,2-Dichloroethene	1.2837	2.02E+2 (25°C)	8.00E+02	1.58E+02	3.55E+01[4]	4.08E-3 (24.8°C)	1.4E+1[3]	3.66E+00
Methylene chloride	1.3266	4.29E+2 (25°C)	1.67E+4 (25°C)	1.78E+01	1.17E+01[4]	3.19E-3 (25°C)	6.00E+00	5.79E+00
trans-1,2-Dichloroethene	1.2565	3.31E+02	6.30E+03	1.17E+22	5.25E+01	9.38E-03	4.80E+01	4.60E+00
Trichlorofluoromethane	1.494	8.03E+02	1.10E+03	3.39E+02	1.58E+02	2.39E+00	4.70E+01	3.75E+00
Vinyl chloride	0.9106	2.58E+03	1.1E+3 (25°C)	3.98E+00	1.86E+01[4]	2.78E-2 (25°C)	5.70E+00	5.18E+00
POLYNUCLEAR AROMATIC HYDROCARBONS (PAHs)								
2-Methylnaphthalene	1.0058	1E+1 (105°C)	2.6E+1 (25°C)	7.24E+03	7.27E+2 [9]	4.99E-4 (25°C)	5.1E+2 [6]	-4.47E-01
Naphthalene	1.162	8.2E-2 (25°C)	3E+1 (25°C)	2.34E+03	2.00E+03 [10]	4.83E-4 (25°C)	4.20E+02	-2.91E+00
PCBs								
Aroclor-1260	1.58 (25°C)(4)	4.05E-5(4)	2.7E-3(4)	1.4E+7(4)	6.70E+06	7.4E-1(4)	1.30E+06	-1.38E+01

Notes:

1 - EPA, September 1992, Handbook of RCRA Groundwater Monitoring Constituents: Chemical and Physical Properties.
2 - EPA, December 1982, Aquatic Fate Process Data for Organic Priority Pollutants.
3 - Lyman et al., 1990; Equation 5-3, Handbook of Chemical Property Estimation Methods.
4 - EPA, July 1996, Soil Screening Guidance.
5 - ATSDR, October 1989, Toxicity Profile for Xylenes.
6 - Lyman et al., 1990, Eq. 5-2
7 - Howard, 1989. Handbook of Environmental Fate and Exposure Data for Organic Chemicals, Volume 1.
8 - Lyman et al., 1990. Equation 4-5
9 - EPA, July 1996. Soil Screening Guidance.
°C = Degrees Celsius

TABLE 2-6

SUMMARY OF CALCULATED RISKS
SITE 6A - FUEL CALIBRATION AREA
NWIRP CALVERTON, NEW YORK

Medium	Exposure Route	Hazard Index				Incremental Cancer Risk			
		Current Maintenance Worker	Current Adolescent Recreational User	Future Adult Resident	Future Child Resident	Current Maintenance Worker	Current Adolescent Recreational User	Future Adult Resident	Future Child Resident
Soil	Incidental Ingestion	2.1×10^{-6}	NA	8.8×10^{-3}	8.2×10^{-2}	3.6×10^{-8}	NA	1.7×10^{-6}	NA
	Dermal Contact	1.4×10^{-5}	NA	3.2×10^{-2}	5.4×10^{-2}	7.5×10^{-7}	NA	6.4×10^{-6}	NA
Groundwater	Ingestion	NA	NA	7.3	17	NA	NA	2.1×10^{-3}	NA
	Dermal Contact	NA	NA	0.49	0.85	NA	NA	8.0×10^{-5}	NA
	Inhalation of Volatiles	NA	NA	1.1	4.9	NA	NA	2.8×10^{-4}	NA
TOTAL		**1.6×10^{-5}**	**NA**	**8.9**	**23.6**	**7.9×10^{-7}**	**NA**	**2.5×10^{-3}**	**NA**

NA - Exposure route not applicable for receptor, as noted.

TABLE 2-7

ARAR AND TBC STANDARDS FOR POTENTIAL SOIL CONTAMINANTS OF CONCERN (mg/kg)
SITE 6A - FUEL CALIBRATION AREA
NWIRP, CALVERTON, NEW YORK

CAS Number	Parameter	Maximum Detection	Location/Date of Detection	TAGM 4046[1]
Volatile Organic Compounds				
1330-20-7	Total Xylenes	17	FC-SB-04/1994	1.2
Semivolatile Organic Compounds				
50-32-8	Benzo(a)pyrene	0.11	FC-SB-04/1994	0.061
78-59-1	Isophorone	5	FC-SB-05/1994	4.4
91-57-6	2-Methylnaphthalene	37	FC-SB-04/1994	36.4
91-20-3	Naphthalene	15	FC-SB-04/1994	13
98-95-3	Nitrobenzene	2.4	FC-SB-05/1994	0.2
88-75-5	2-Nitrophenol	5.8	FC-SB-04/1994	0.33
108-95-2	Phenol	0.047	FC-SB-04/1994	0.03
PCBs				
11096-82-5	Aroclor-1260	14[2]	Free Product Sample CG	1 surface, 10 subsurface

1 - Technical and Administrative Guidance Memorandum #4046, Determination of Soil Cleanup Objectives and Cleanup Levels, Tables 1 and 2.

2 - PCB concentration was estimated based on a free product analysis of 2,800 mgkg and assuming that the soils contained 0.5% petroleum product.

TABLE 2-8

ARAR AND TBC STANDARDS FOR POTENTIAL GROUNDWATER CONTAMINANTS OF CONCERN (µg/L)
SITE 6A - FUEL CALIBRATION AREA
NWIRP CALVERTON, NEW YORK

CAS Number	Parameter	Maximum Detection	Location/Date of Detection	Federal MCL(1)	New York State Standards/Guidance			
					MCL(2)	GW Quality Standard(3)	GW Effluent Standard(4)	TAGM 4046(5)
Volatile Organic Compounds								
71-55-6	1,1,1-Trichloroethane	2000	FC-MW-02S/2000	200	5	5	NA	5
95-50-1	1,2-Dichlorobenzene	9	FC-MW-02S/1994	600	5	3	3	4.7
75-34-3	1,1-Dichloroethane	3400	FC-MW-02S/2000	NA	5	5	NA	5
75-35-4	1,1-Dichloroethene	30	FC-MW-02S/2000	7	5	5	NA	5
71-43-2	Benzene	43.9	FC-TW-05A/1997	5	5	1	1	0.7
75-00-3	Chloroethane	20	FC-MW-02S/2005	NA	5	5	NA	50
100-41-4	Ethylbenzene	46	FC-MW-02S/2000	700	5	5	NA	5
108-88-3	Toluene	140	FC-MW-02S/2000	1000	5	5	NA	5
1330-20-7	Total Xylenes	510	FC-MW-02S/2000	10000	5	5	NA	5
Semivolatile Organic Compounds								
91-57-6	2-Methylnaphthalene	74	FC-MW-02S/1994	NA	50	NA	NA	50
106-44-5	4-Methylphenol	84	FC-MW-02S/1994	NA	50	1	2	50
91-20-3	Naphthalene	120	FC-MW-02S/1994	NA	50	NA	NA	10

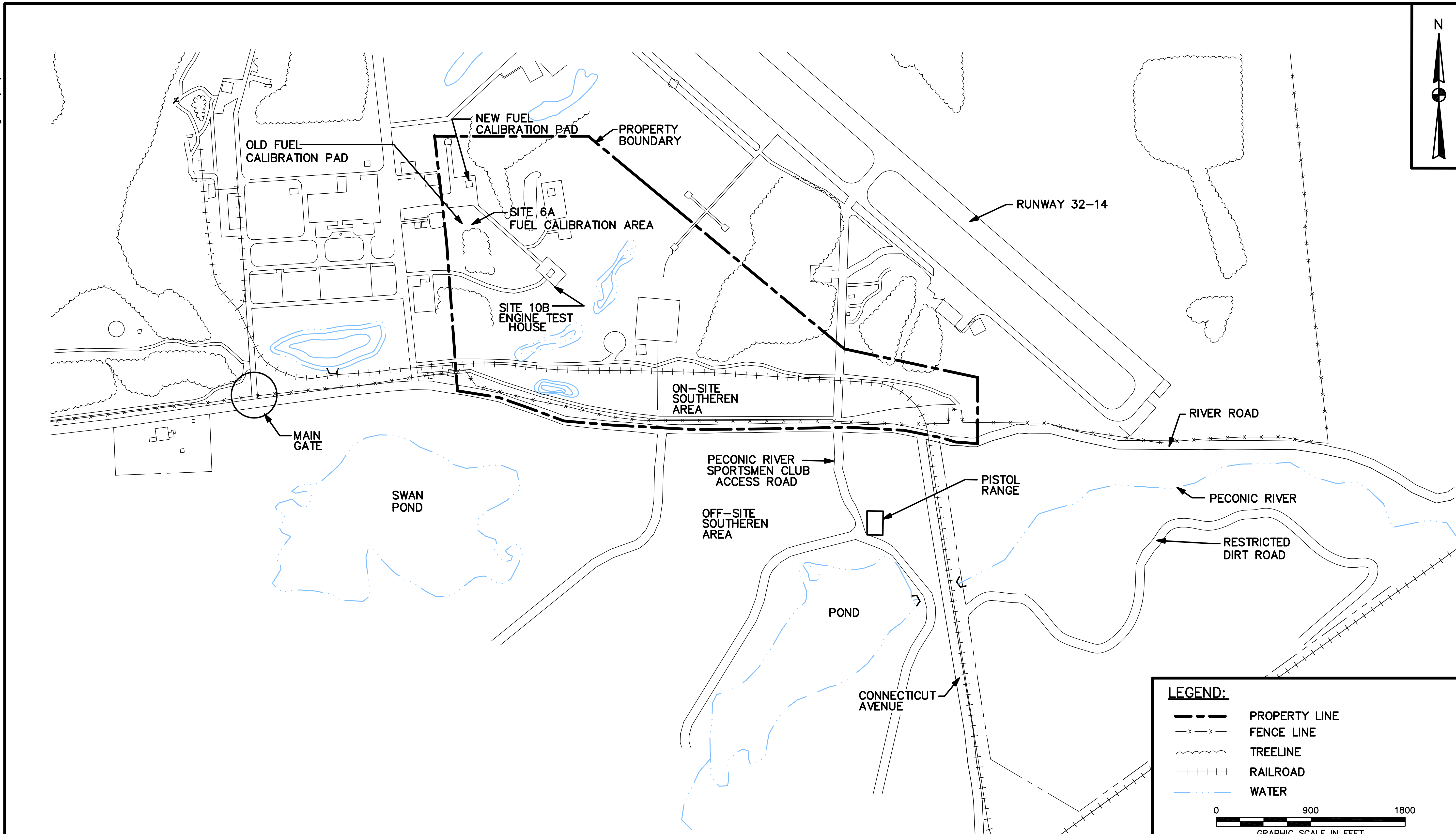
GW - Groundwater
MCL - Maximum Contaminant Level
NA - Not Available
1 - 2004 (Winter) Edition of the Drinking Water Standards and Health Advisories, Office of Water, EPA (EPA-822-R-04-005).
2 - New York Public Supply Regulations, 10 NYCRR Part 5, Subpart 5-1 Public Water Systems, Table 3 - Organic Chemicals Maximum Contaminant Level Determination and Table 9D - Organic Chemicals - Principal Organic Contaminants.
3 - 6 NYCRR Part 703 Surface Water and Groundwater Quality Standards and Groundwater Effluent Limitations, NYSDEC, Section 703.5, Table 1.
4 - 6 NYCRR Part 703, Surface Water and Groundwater Quality Standards and Groundwater Effluent Limitations, NYSDEC, Section 703.6, Table 3.
5 - Technical and Administrative Guidance Memorandum #4046, Determination of Soil Cleanup Objectives and Cleanup Levels, Tables 1 and 2.

TABLE 2-9

ARAR AND TBC STANDARDS FOR POTENTIAL GROUNDWATER CONTAMINANTS OF CONCERN (µg/L)
SITE 10B - ENGINE TEST HOUSE AND ON-SITE SOUTHERN AREA PLUME
NWIRP CALVERTON, NEW YORK

CAS Number	Parameter	Maximum Detection	Location/Date of Detection	Federal MCL(1)	New York State Standards/Guidance			
					MCL(2)	GW Quality Standard(3)	GW Effluent Standard(4)	TAGM 4046(5)
Volatile Organic Compounds								
71-55-6	1,1,1-Trichloroethane	166	ET-TW-05A/1997	200	5	5	NA	5
76-13-1	1,1,2-Trichlorotrifluoroethane	152	ET-TW-07A/1997	NA	5	5	NA	5
75-34-3	1,1-Dichloroethane	49.2	ET-TW-15A/1997	NA	5	5	NA	5
75-35-4	1,1-Dichloroethene	188	ET-TW-05A/1997	7	5	5	NA	5
71-43-2	Benzene	1.95	ET-TW-07A/1997	5	5	1	1	0.7
74-83-9	Bromomethane	353	ET-TW-03A/1997	NA	5	5	NA	NA
108-90-7	Chlorobenzene	381	ET-TW-01A/1997	NA	5	5	NA	5
75-00-3	Chloroethane	138	ET-TW-05A/1997	NA	5	5	NA	50
67-66-3	Chloroform	15.3	ET-TW-02A/1997	80	100 (THM)	7	7	7
100-41-4	Ethylbenzene	1084	ET-TW-03A/1997	700	5	5	NA	5
75-09-2	Methylene Chloride	7	ET-TW-05A/1997	5	5	5	5	5
108-88-3	Toluene	337	ET-TW-01A/1997	1000	5	5	NA	5
1330-20-7	Total Xylenes	196	ET-TW-03A/1997	10000	5	5	NA	5
75-01-4	Vinyl Chloride	59.8	ET-TW-07A/1997	2	2	2	2	2

GW - Groundwater
MCL - Maximum Contaminant Level
NA - Not Available
THM - Trihalomethane
1 - 2004 (Winter) Edition of the Drinking Water Standards and Health Advisories, Office of Water, EPA (EPA-822-R-04-005).
2 - New York Public Supply Regulations, 10 NYCRR Part 5, Subpart 5-1 Public Water Systems, Table 3 - Organic Chemicals Maximum Contaminant Level Determination and Table 9D - Organic Chemicals - Principal Organic Contaminants.
3 - 6 NYCRR Part 703 Surface Water and Groundwater Quality Standards and Groundwater Effluent Limitations, NYSDEC, Section 703.5, Table 1.
4 - 6 NYCRR Part 703, Surface Water and Groundwater Quality Standards and Groundwater Effluent Limitations, NYSDEC, Section 703.6, Table 3.
5 - Technical and Administrative Guidance Memorandum #4046, Determination of Soil Cleanup Objectives and Cleanup Levels, Table 1.



DRAWN BY DM	DATE 10/17/05	Tetra Tech NUS, Inc.	SITE LAYOUT SITE 6A, SITE 10B, AND SOUTHERN AREA NWIRP CALVERTON CALVERTON, NEW YORK	CONTRACT NO. 1610	
CHECKED BY	DATE			OWNER NO. 0004	
REVISED BY	DATE			APPROVED BY	DATE
SCALE AS NOTED				DRAWING NO. FIGURE 2-1	REV. 0

FORM CADD NO. TTNUS-BH.DWG - REV 1 - 9/10/98

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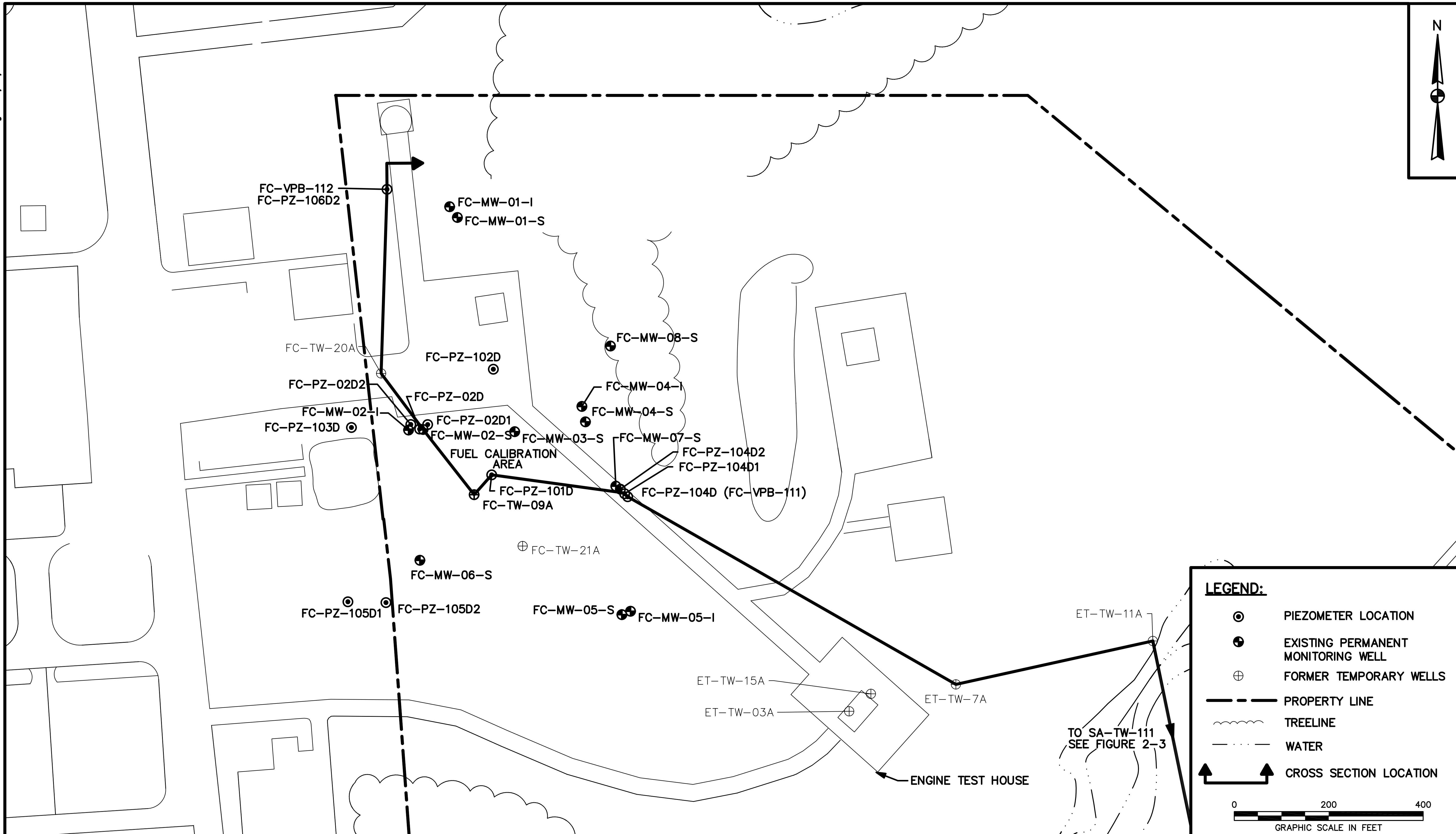


DRAWN BY	DATE
DM	10/17/05
CHECKED BY	DATE
REVISED BY	DATE
SCALE AS NOTED	

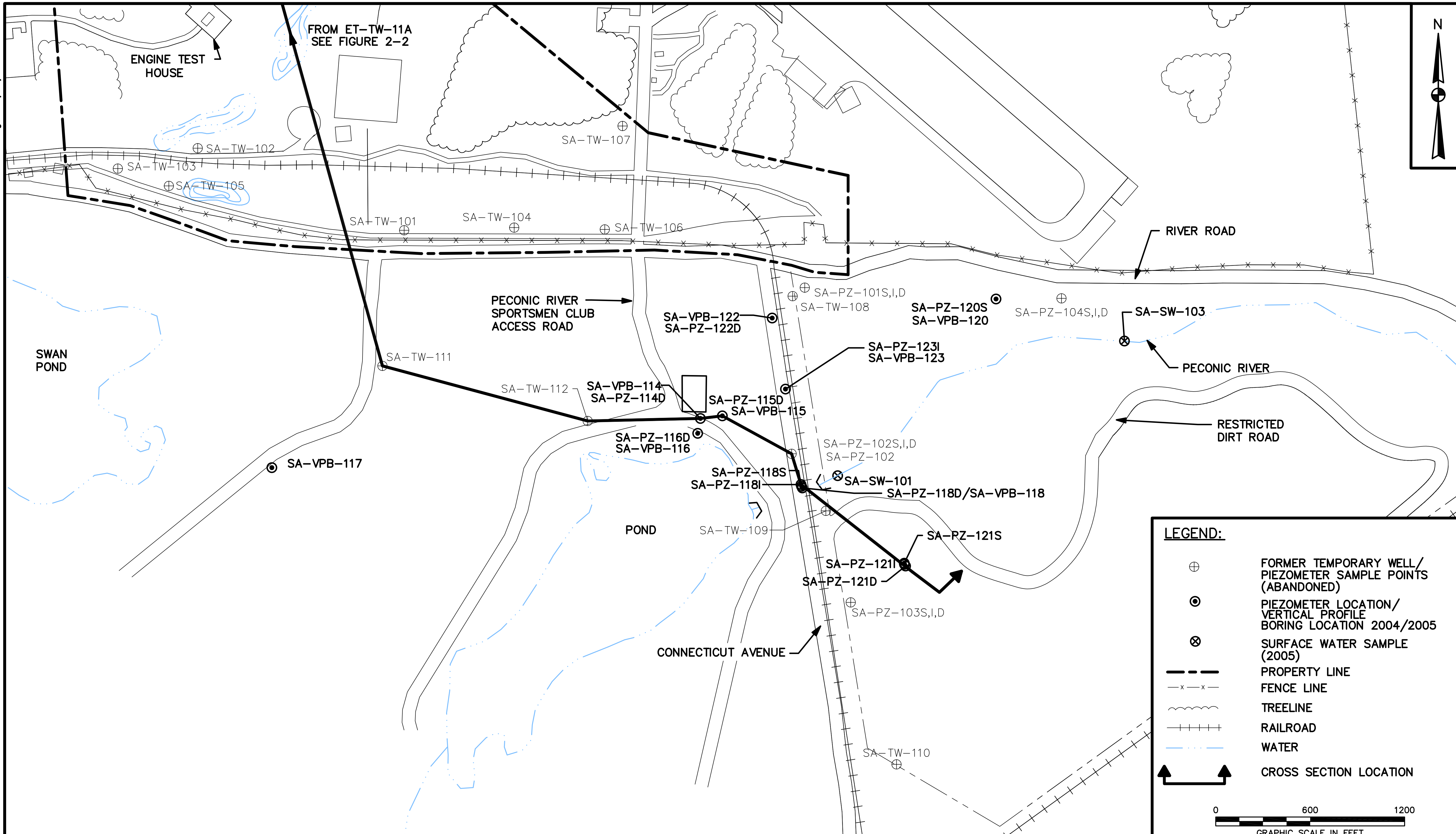
Tetra Tech NUS, Inc.

CROSS SECTION LOCATION MAP
SITE 6A - FUEL CALIBRATION AREA AND
SITE 10B - ENGINE TEST HOUSE
NWIRP CALVERTON
CALVERTON, NEW YORK

CONTRACT NO. 1610
OWNER NO. 0004
APPROVED BY | DATE
DRAWING NO. FIGURE 2-2
REV. 0

FORM CADD NO. TTNUS-BH.DWG - REV 1 - 9/10/98

ACAD: 1610CP23.dwg 07/28/05 DM PIT



DRAWN BY	DATE
DM	6/24/05
CHECKED BY	DATE
REVISED BY	DATE
SCALE AS NOTED	

Tetra Tech NUS, Inc.

SAMPLE LOCATION
AND CROSS SECTION LOCATION MAP
SOUTHERN AREA
NWIRP CALVERTON
CALVERTON, NEW YORK

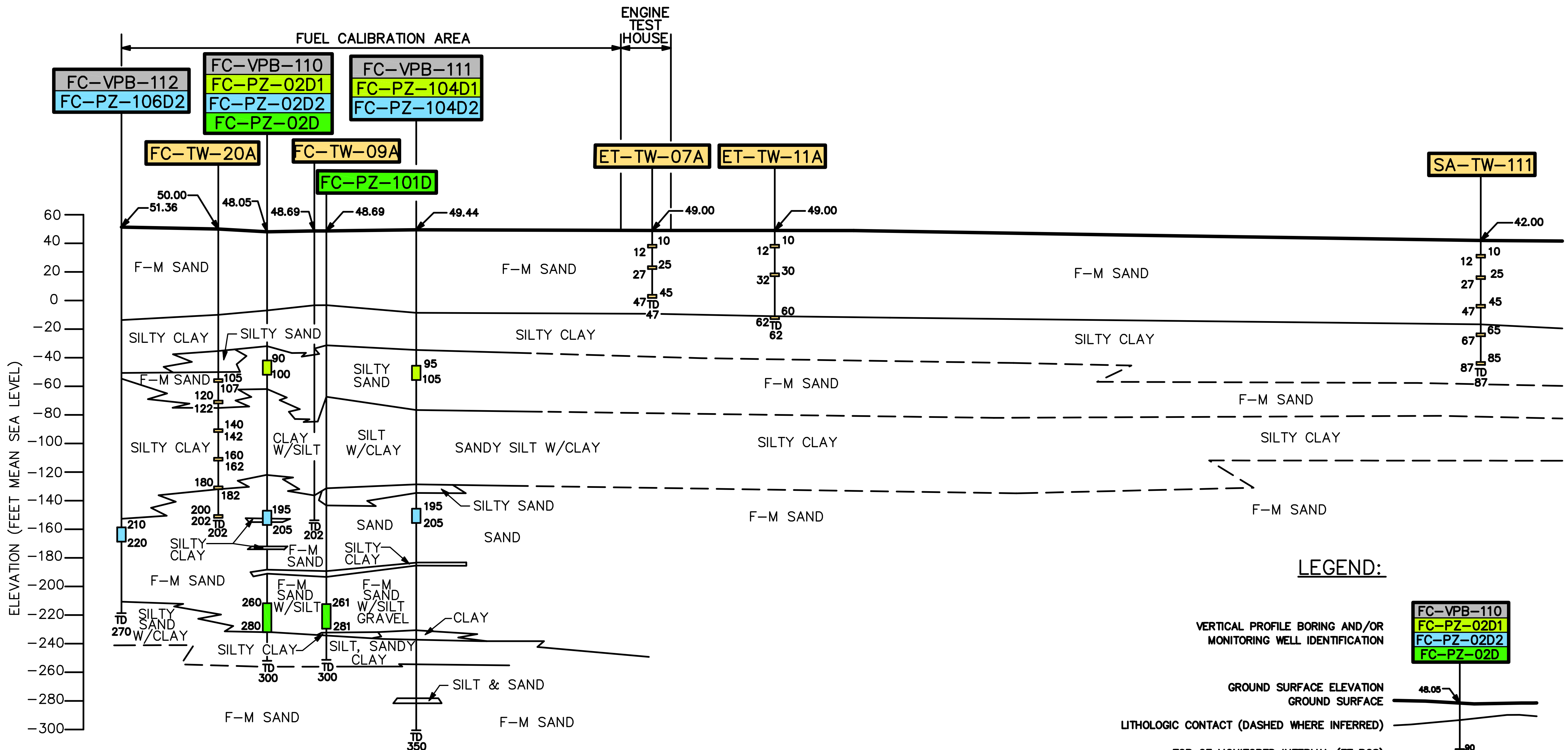
CONTRACT NO. 1610

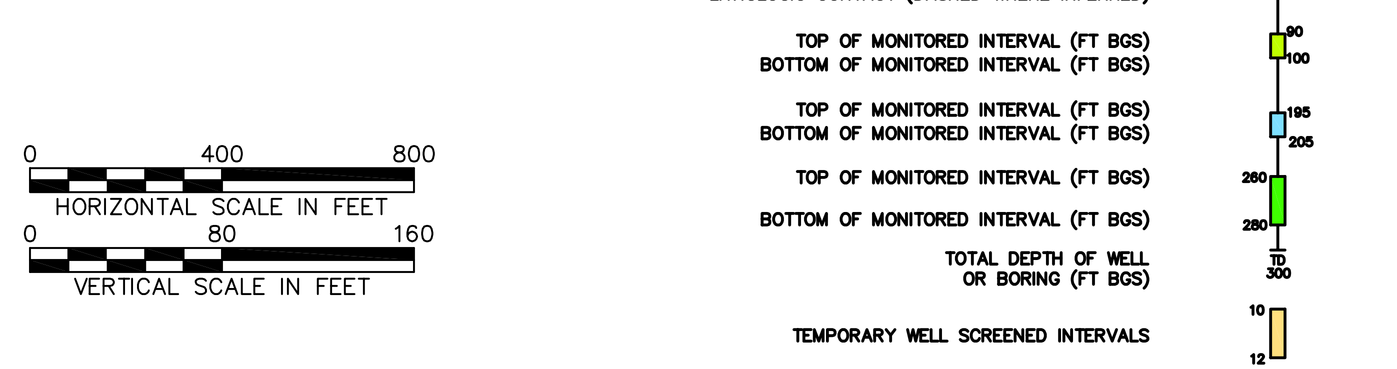
OWNER NO. 0000

APPROVED BY DATE

DRAWING NO. FIGURE 2-3 REV. 0

ACAD:1610CX11.dwg 10/17/05 DM PIT





NOTES:

1.) WELL CLUSTERS ARE PROJECTED AND REPRESENTED AS A SINGLE VERTICAL BORING/MONITORING WELL.

2.) VERTICAL PROFILE BORINGS (VPB) WERE COMPLETED AFTER WELL/BORING INSTALLATION.

3.) TEMPORARY WELLS ARE VARIABLY SCREENED THROUGHOUT VERTICAL SECTIONS.

DRAWN BY	DATE
DM	10/17/05
CHECKED BY	DATE
SRA	7/15/05
REVISED BY	DATE
SCALE	
AS NOTED	

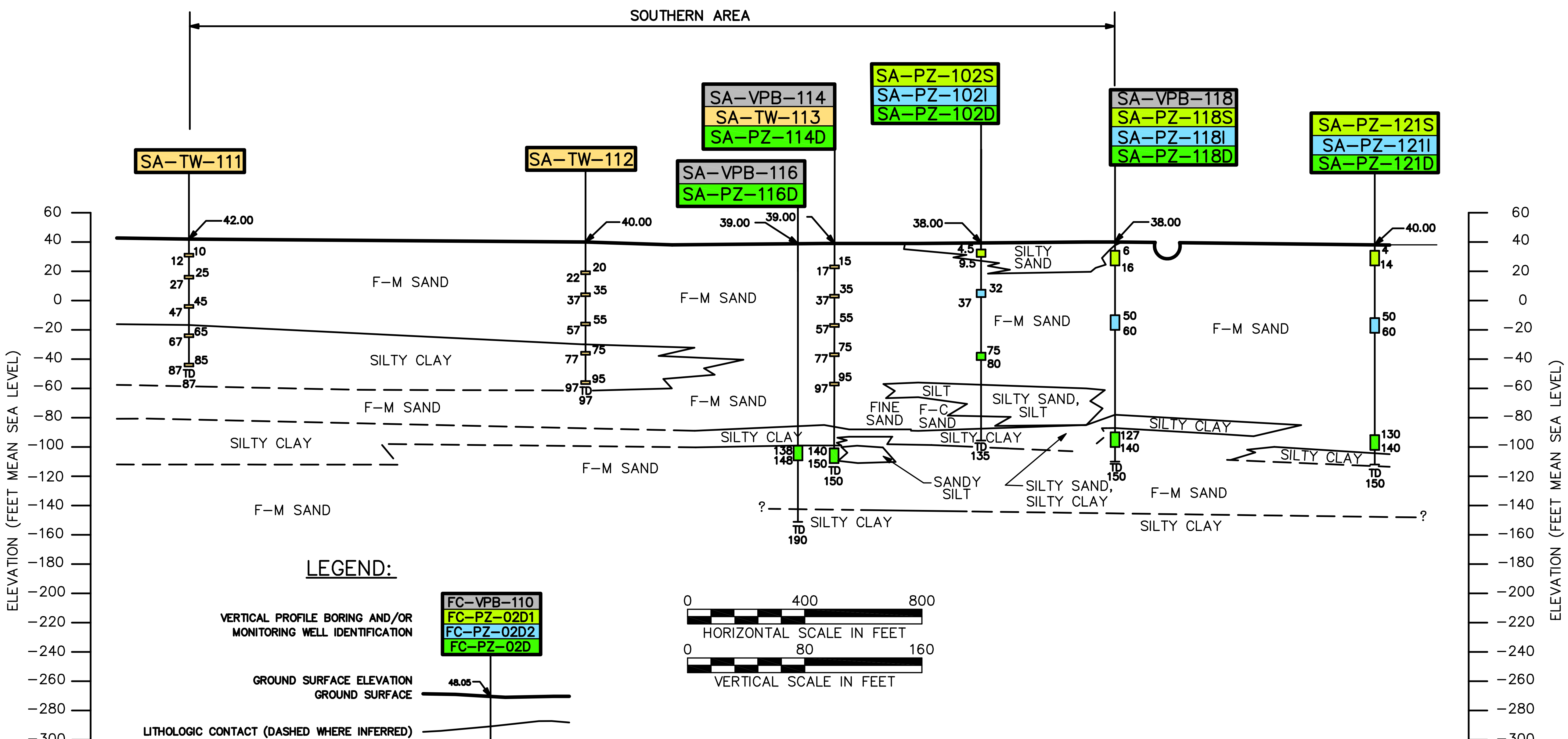
Tetra Tech NUS, Inc.

GEOLOGICAL CROSS SECTION SITE 6A - FUEL CALIBRATION AREA AND SITE 10B - ENGINE TEST HOUSE NWIRP CALVERTON CALVERTON, NEW YORK

CONTRACT NO.	
1610	
OWNER NO.	
0004	
APPROVED BY	DATE
DRAWING NO.	REV.
FIGURE 2-4	0

FORM CADD NO. TTNUS-BH.DWG - REV 1 - 9/10/98

ACAD:1610CX12.dwg 10/17/05 DM PIT



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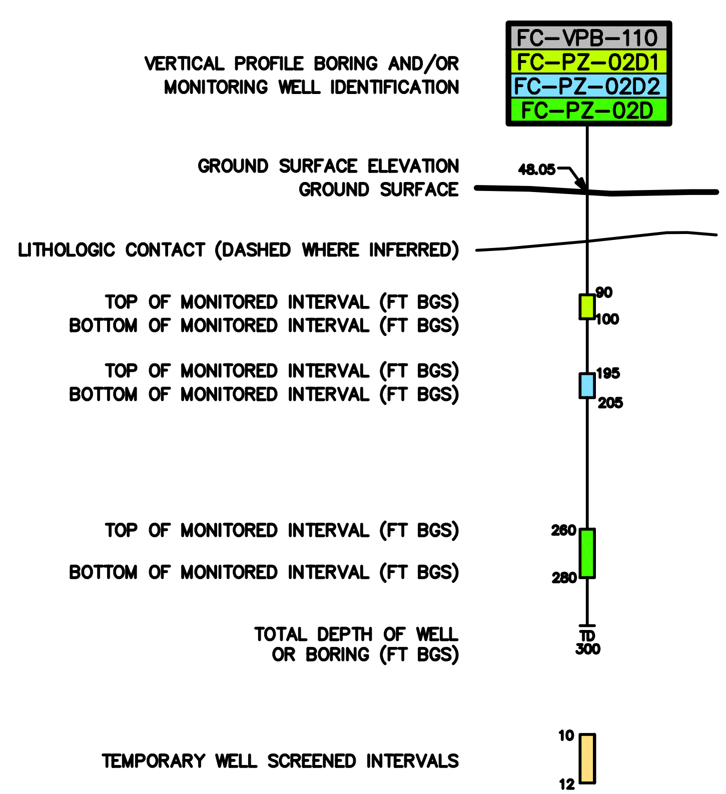


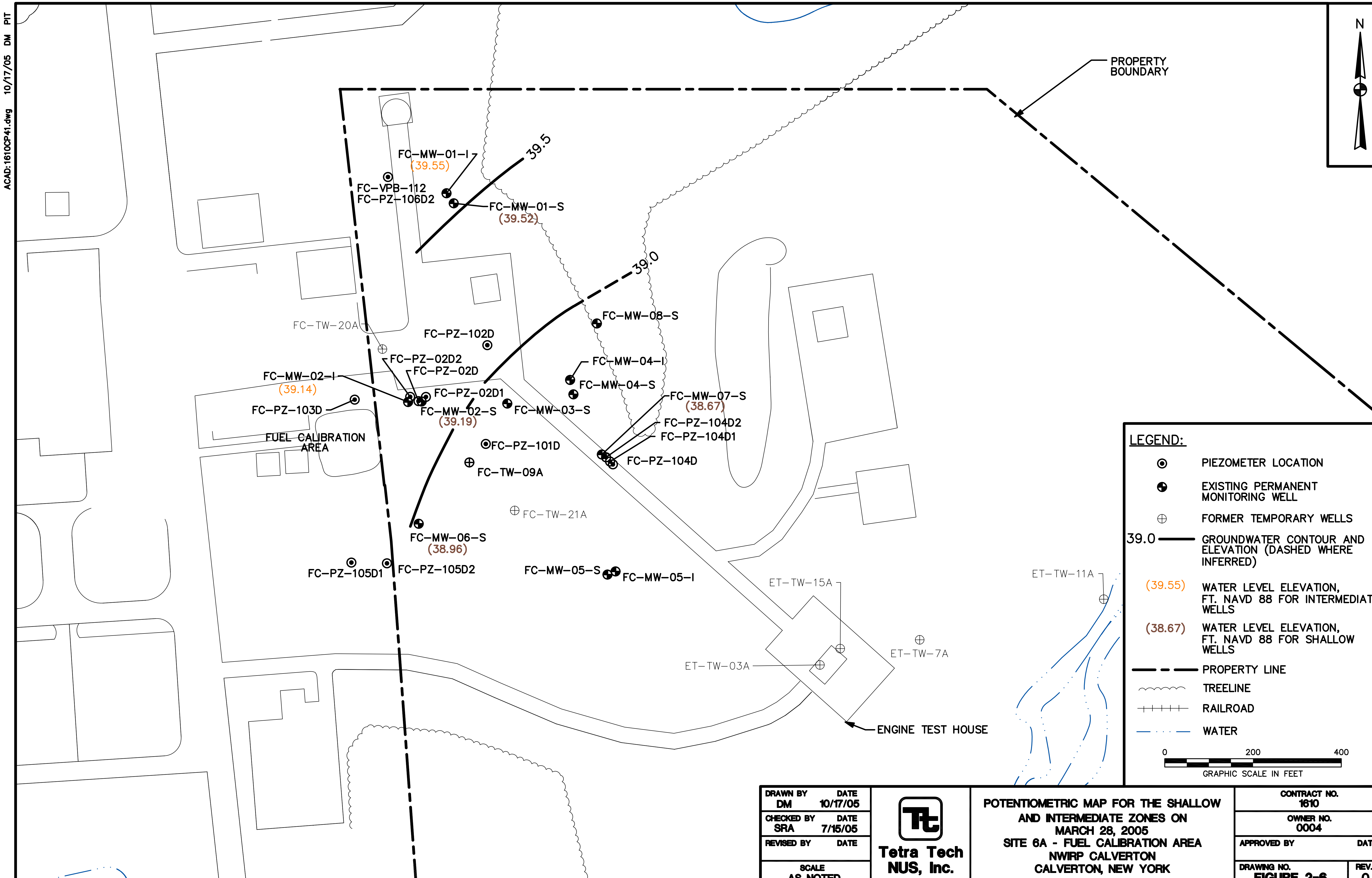
NOTES:

1.) WELL CLUSTERS ARE PROJECTED AND REPRESENTED AS A SINGLE VERTICAL BORING/MONITORING WELL.

2.) VERTICAL PROFILE BORINGS (VPB) WERE COMPLETED AFTER WELL/BORING INSTALLATION.

3.) TEMPORARY WELLS ARE VARIABLY SCREENED THROUGHOUT VERTICAL SECTIONS.

DRAWN BY DM	DATE 10/17/05	Tetra Tech NUS, Inc.	GEOLOGICAL CROSS SECTION SOUTHERN AREA NWIRP CALVERTON CALVERTON, NEW YORK	CONTRACT NO. 1610	
CHECKED BY	DATE			OWNER NO. 0004	
REVISED BY	DATE			APPROVED BY	DATE
SCALE AS NOTED				DRAWING NO. FIGURE 2-5	REV. 0



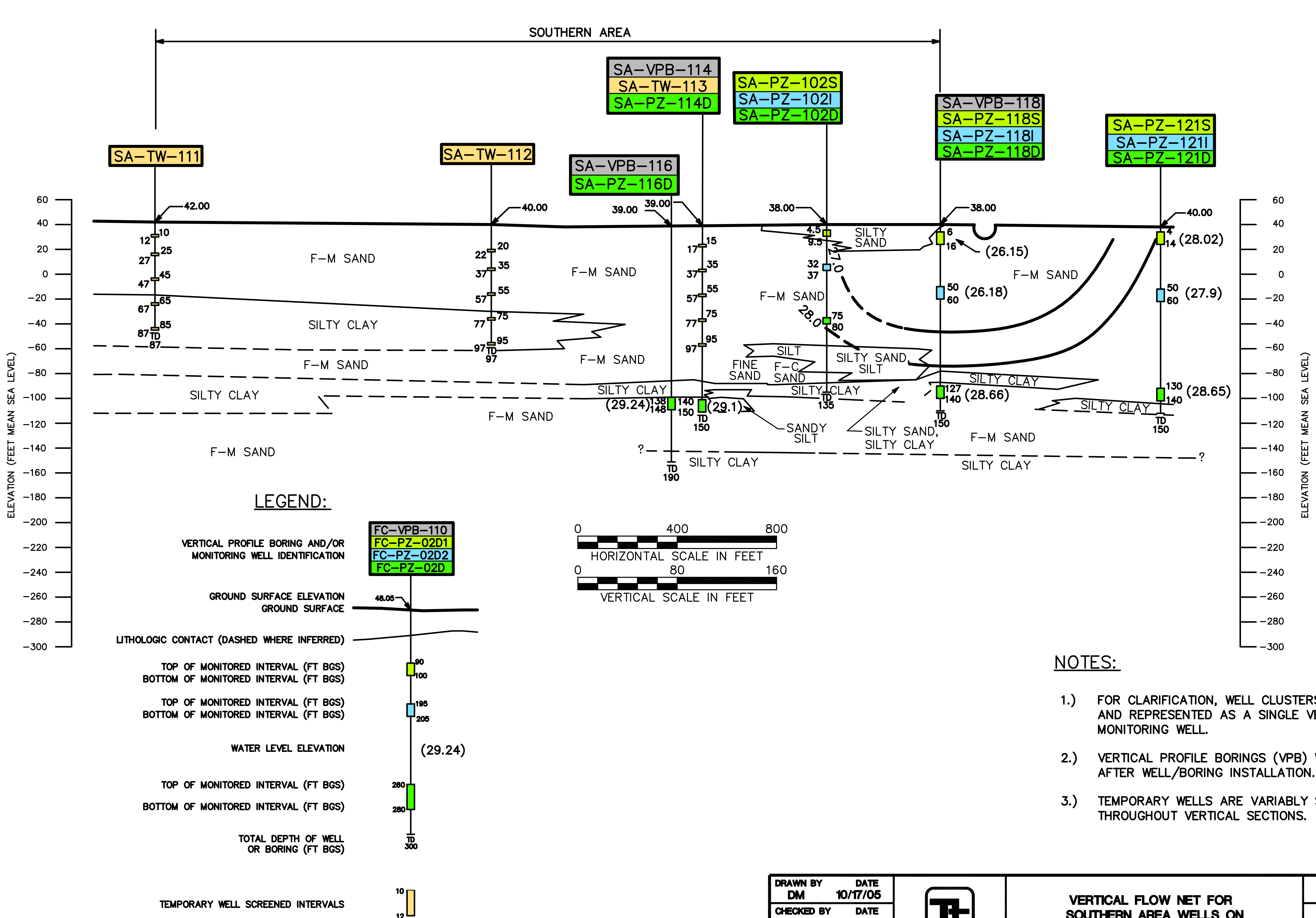
DRAWN BY	DATE
DM	10/17/05
CHECKED BY SRA	DATE 7/15/05
REVISED BY	DATE
SCALE AS NOTED	

Tetra Tech NUS, Inc.

POTENTIOMETRIC MAP FOR THE SHALLOW AND INTERMEDIATE ZONES ON MARCH 28, 2005
SITE 6A - FUEL CALIBRATION AREA
NWIRP CALVERTON
CALVERTON, NEW YORK

CONTRACT NO.	
1610	
OWNER NO. 0004	
APPROVED BY	DATE
DRAWING NO. FIGURE 2-6	REV. 0

FORM CADD NO. TTNUS-BH.DWG - REV 1 - 9/10/98



ACAD:1610CX13.dwg 10/17/05 DM PIT

NOTES:

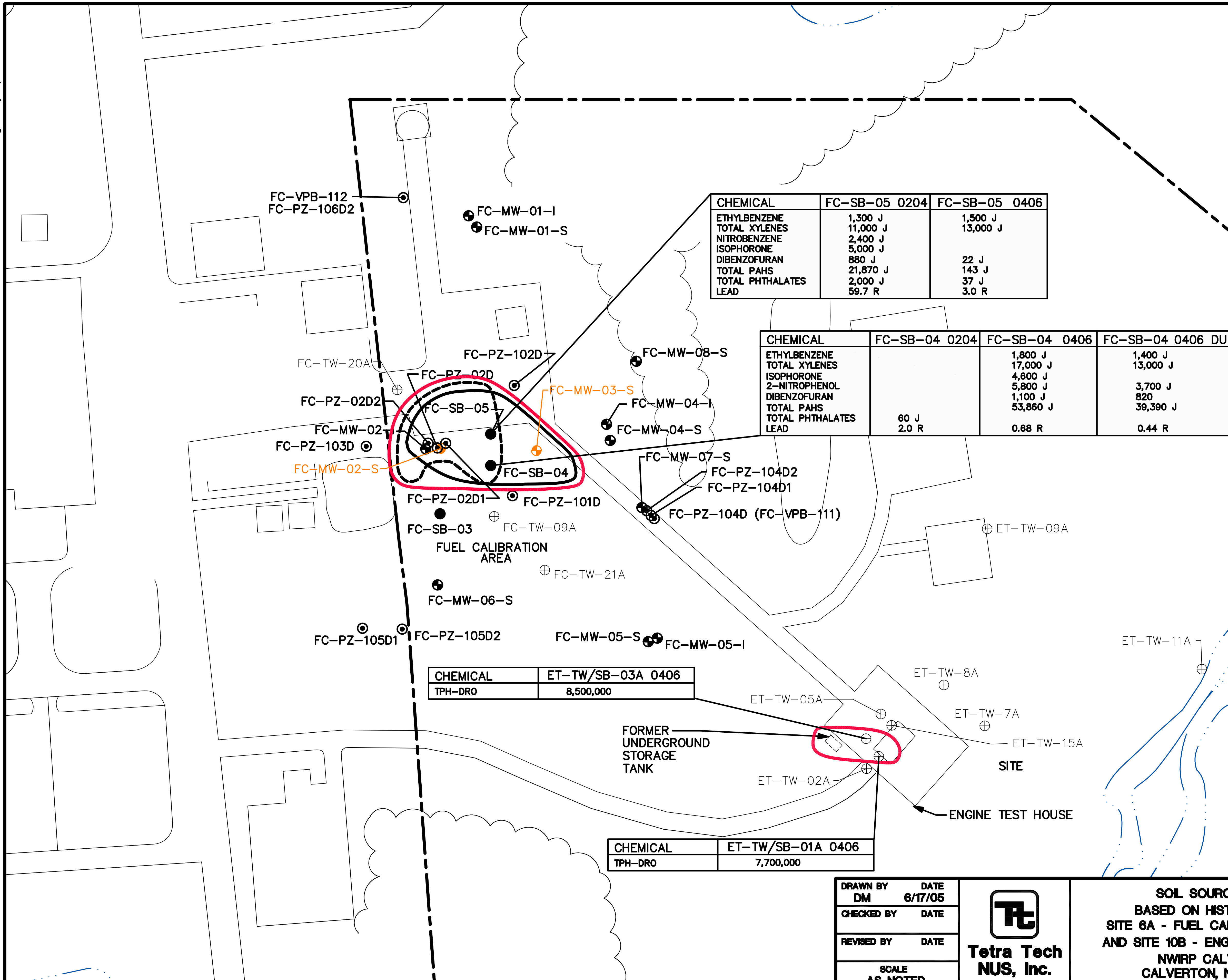
1.) FOR CLARIFICATION, WELL CLUSTERS ARE PROJECTED AND REPRESENTED AS A SINGLE VERTICAL BORING/ MONITORING WELL.

2.) VERTICAL PROFILE BORINGS (VPB) WERE COMPLETED AFTER WELL/BORING INSTALLATION.

3.) TEMPORARY WELLS ARE VARIABLY SCREENED THROUGHOUT VERTICAL SECTIONS.

DRAWN BY DM	DATE 10/17/05	Tetra Tech NUS, Inc.	VERTICAL FLOW NET FOR SOUTHERN AREA WELLS ON MARCH 28, 2005 NWIRP CALVERTON CALVERTON, NEW YORK	CONTRACT NO. 1610
CHECKED BY SRA	DATE 7/20/05			OWNER NO.
REVISED BY	DATE			APPROVED BY / DATE
SCALE AS NOTED				DRAWING NO. FIGURE 2-7 / REV. 0

FORM CADD NO. TTNUS-BH.DWG - REV 1 - 9/10/98



CHEMICAL	FC-SB-05 0204	FC-SB-05 0406
ETHYLBENZENE	1,300 J	1,500 J
TOTAL XYLENES	11,000 J	13,000 J
NITROBENZENE	2,400 J	
ISOPHORONE	5,000 J	
DIBENZOFURAN	880 J	22 J
TOTAL PAHS	21,870 J	143 J
TOTAL PHTHALATES	2,000 J	37 J
LEAD	59.7 R	3.0 R

CHEMICAL	FC-SB-04 0204	FC-SB-04 0406	FC-SB-04 0406 DU
ETHYLBENZENE		1,800 J	1,400 J
TOTAL XYLENES		17,000 J	13,000 J
ISOPHORONE		4,600 J	
2-NITROPHENOL		5,800 J	3,700 J
DIBENZOFURAN		1,100 J	820
TOTAL PAHS		53,860 J	39,390 J
TOTAL PHTHALATES	60 J		
LEAD	2.0 R	0.68 R	0.44 R

CHEMICAL	ET-TW/SB-03A 0406
TPH-DRO	8,500,000

CHEMICAL	ET-TW/SB-01A 0406
TPH-DRO	7,700,000

LEGEND:

- SOIL BORING LOCATION
- PIEZOMETER LOCATION
- EXISTING PERMANENT MONITORING WELL
- PID READING, SHEEN ON WATER TABLE, OR FUEL ODOR IN PURGE WATER DURING 2005 SAMPLING
- FORMER TEMPORARY WELLS
- 10 µg/L (MICROGRAMS PER LITER) CHLORINATED VOC SOIL GAS CONTOUR FROM RFI (HNUS, 1995)
- 10 µg/L (MICROGRAMS PER LITER) BTEX SOIL GAS CONTOUR FROM (HNUS, 1995)
- LIMIT OF SOIL CONTAMINATION (SOURCE AREA)
- PROPERTY LINE
- TREELINE
- WATER

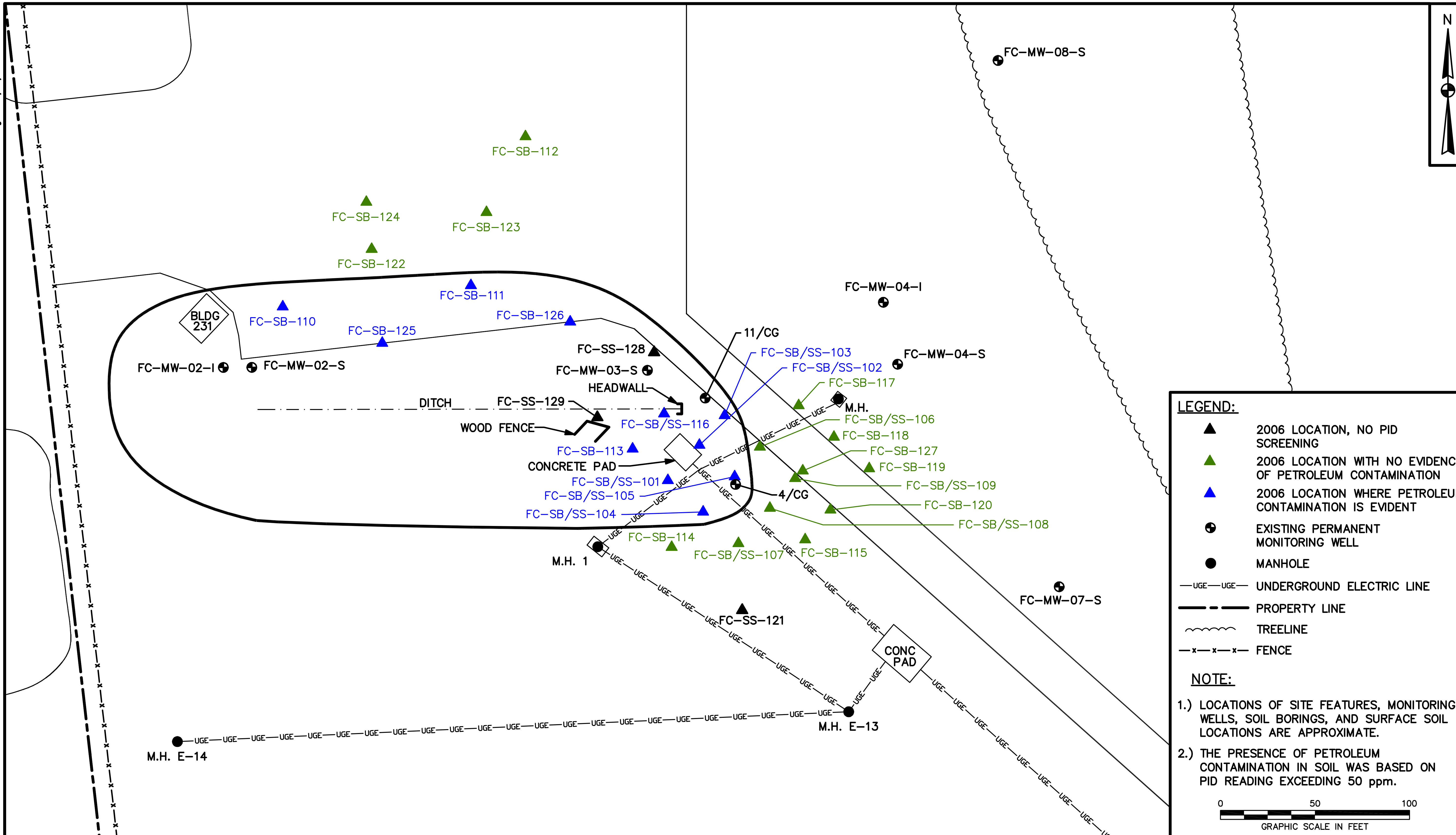
NOTE: SITE 6A AND SITE 10B SOIL DATA PRESENTED IN TAGS WERE TAKEN FROM RFI (HNUS, 1995) AND PHASE 2 RFI (CF BRAUN, 1998), RESPECTIVELY, AND UNITS ARE µg/kg (MICROGRAMS PER KILOGRAM).

0 200 400

GRAPHIC SCALE IN FEET

DRAWN BY DM	DATE 6/17/05	Tetra Tech NUS, Inc.	SOIL SOURCE AREA BASED ON HISTORIC DATA SITE 6A - FUEL CALIBRATION AREA AND SITE 10B - ENGINE TEST HOUSE NWIRP CALVERTON CALVERTON, NEW YORK	CONTRACT NO. 1610	
CHECKED BY	DATE			OWNER NO. 0004	
REVISED BY	DATE			APPROVED BY	DATE
SCALE AS NOTED				DRAWING NO. FIGURE 2-8	REV. 0

FORM CADD NO. TTNUS-BH.DWG - REV 1 - 9/10/98



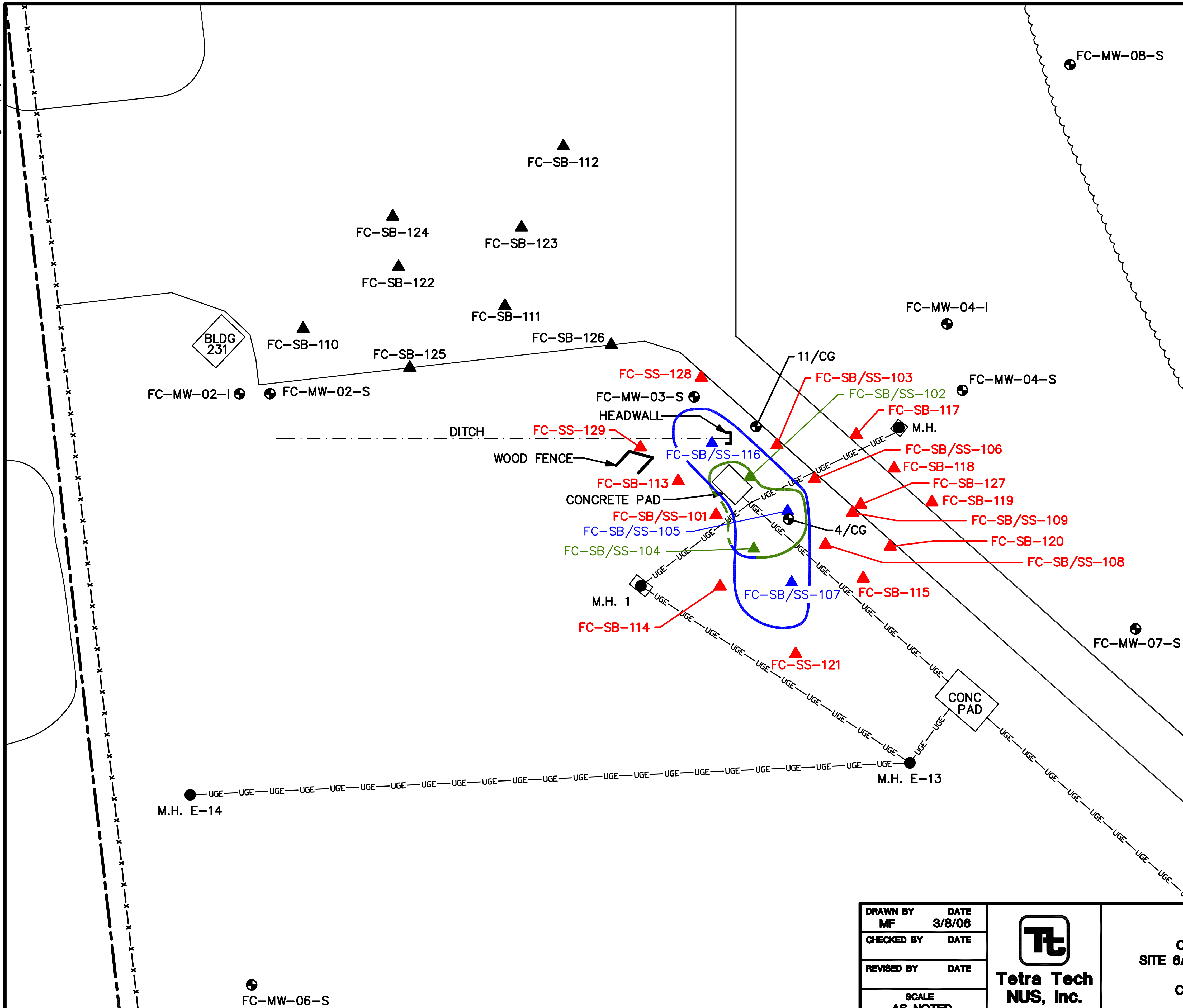
DRAWN BY MF	DATE 3/8/06	CONTRACT NO. 1610	
CHECKED BY	DATE	OWNER NO. 004	
REVISED BY	DATE	APPROVED BY	DATE
SCALE AS NOTED		DRAWING NO. FIGURE 2-9	REV. 0

Tetra Tech NUS, Inc.

REVISED EXTENT OF PETROLEUM CONTAMINATION IN SOIL
SITE 6A - FUEL CALIBRATION AREA
NWIRP CALVERTON
CALVERTON, NEW YORK

ACAD:1610CM26.dwg 04/11/06 MF PIT

FORM CADD NO. TTNUS-BH.DWG - REV 1 - 9/10/98



LEGEND:

- EXTENT OF PCB CONTAMINATION IN SUB-SURFACE SOIL (GROUNDWATER INTERFACE)
- EXTENT OF PCB CONTAMINATION IN SURFACE SOIL
- 2006 LOCATION, NO PCB SAMPLING
- 2006 LOCATION WHERE PCB CONCENTRATIONS EXCEED SCREENING CRITERIA (SURFACE SOIL ONLY)
- 2006 LOCATION WHERE PCB CONCENTRATIONS EXCEED SCREENING CRITERIA (SURFACE AND SUBSURFACE SOIL)
- 2006 LOCATION WHERE PCB CONCENTRATIONS ARE BELOW SCREENING CRITERIA (SURFACE AND SUBSURFACE SOIL)
- EXISTING PERMANENT MONITORING WELL
- MANHOLE
- —UGE—UGE— UNDERGROUND ELECTRIC LINE
- PROPERTY LINE
- TREELINE
- —x—x—x— FENCE

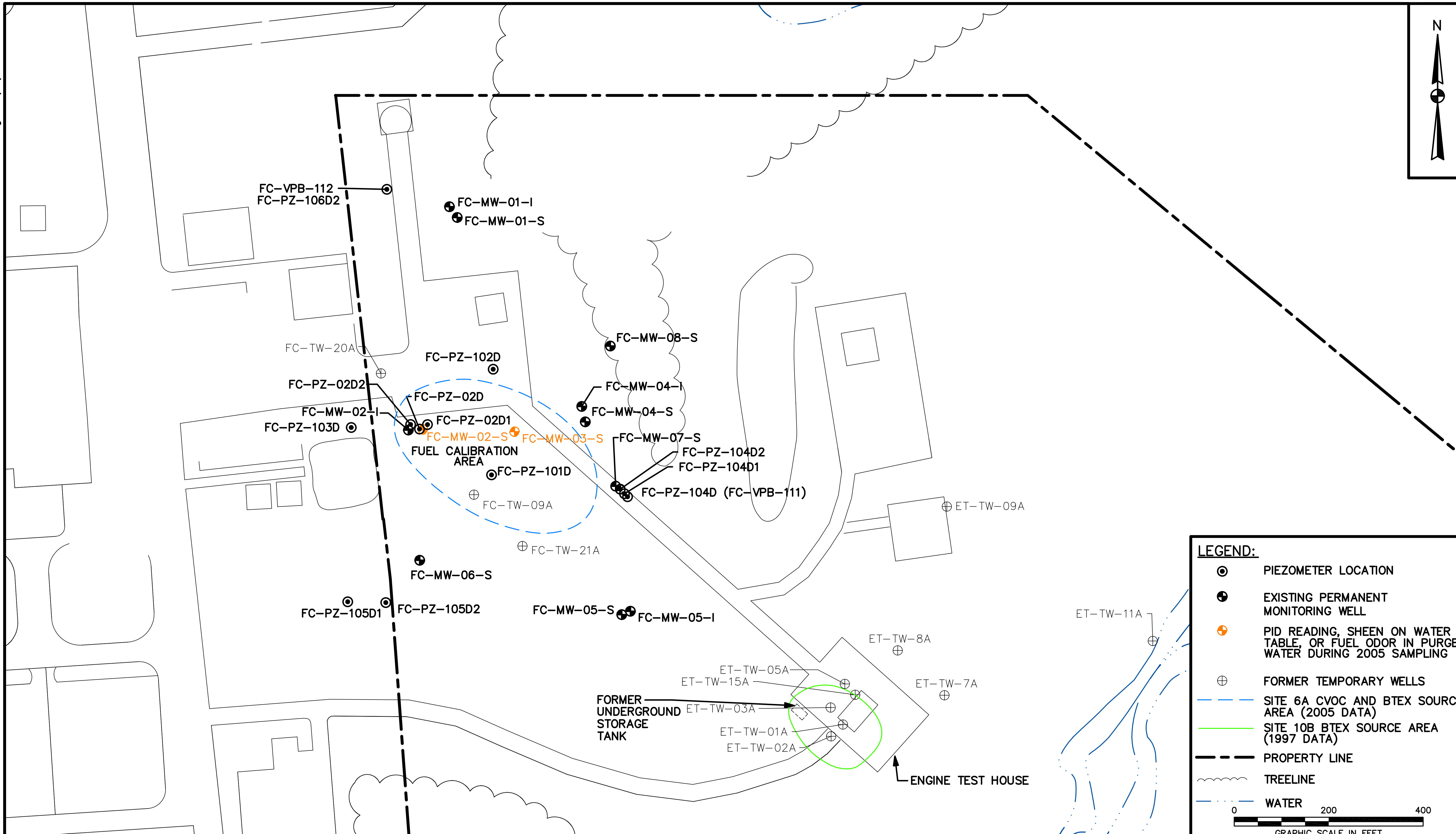
NOTE:

1.) LOCATIONS OF SITE FEATURES, MONITORING WELLS, SOIL BORINGS, AND SURFACE SOIL LOCATIONS ARE APPROXIMATE.

2.) THE PRESENCE OF PCB CONTAMINATION IN SOIL WAS BASED ON SAMPLE RESULTS EXCEEDING 1 ppm IN SURFACE SOIL AND 10 ppm IN SUBSURFACE SOIL.

0 50 100
GRAPHIC SCALE IN FEET

DRAWN BY MF	DATE 3/8/06	Tetra Tech NUS, Inc.	EXTENT OF PCB CONTAMINATION IN SOIL SITE 6A - FUEL CALIBRATION AREA NWIRP CALVERTON CALVERTON, NEW YORK	CONTRACT NO. 1610	
CHECKED BY	DATE			OWNER NO. 004	
REVISED BY	DATE			APPROVED BY	DATE
SCALE AS NOTED				DRAWING NO. FIGURE 2-10	REV. 0



DRAWN BY	DATE
DM	10/17/05
CHECKED BY	DATE
REVISED BY	DATE
SCALE AS NOTED	

Tetra Tech NUS, Inc.

GROUNDWATER SOURCE AREAS
SITE 6A - FUEL CALIBRATION AREA
AND SITE 10B - ENGINE TEST HOUSE
NWIRP CALVERTON
CALVERTON, NEW YORK

CONTRACT NO. 1610	
OWNER NO. 0004	
APPROVED BY	DATE
DRAWING NO. FIGURE 2-11	REV. 0

FORM CADD NO. TTNUS-BH.DWG - REV 1 - 9/10/98

DRAWN BY	DATE
DM	10/17/05
CHECKED BY	DATE
REVISED BY	DATE
SCALE AS NOTED	

Tetra Tech NUS, Inc.

ONSITE AND OFFSITE SOUTHERN AREA GROUNDWATER CONTAMINANT PLUMES
NWIRP, CALVERTON
CALVERTON, NEW YORK

CONTRACT NO. 1610
OWNER NO. 0004
APPROVED BY | DATE
DRAWING NO. FIGURE 2-12 | REV. 0

FORM CADD NO. TTNUS-D-STD.DWG - REV 1 - 9/11/98

ACAD:1610CP43.dwg 05/11/06 MF PIT

3.0 CORRECTIVE ACTION OBJECTIVES

The following section describes the development of the proposed CAOs for Site 6A, Site 10B, and the On-Site Southern Area Plume at NWIRP Calverton. These CAOs and media clean-up standards are based on promulgated federal and State of New York requirements, risk-derived standards, data and information gathered during previous investigations including the supplemental RFI/RI, and additional applicable guidance documents.

3.1 INTRODUCTION

CAOs are developed for each site as medium-specific and contaminant-specific objectives that will result in the protection of human health and the environment. The development of CAOs for a site is based on human health and environmental criteria, RFI/RI gathered information, EPA guidance, and applicable federal and State regulations. Typically, CAOs are developed based on promulgated standards (e.g., New York State groundwater quality standards), background concentrations determined from a site-specific investigation, and human health and ecological risk-based concentrations developed in accordance with the EPA risk assessment guidance. A complete description of the nature and extent of contamination, contaminant fate and transport, and baseline human health risk assessment for Site 6A, Site 10B, and the On-Site Southern Area Plume are presented in Section 2.0. The purpose of this section is to identify ARARs and develop CAOs for remediation of the contaminated soil/free product and groundwater at Sites 6A and 10B and groundwater in the On-Site Southern Area Plume. The CAOs are based on the contaminants, the results of the risk assessment, and compliance with risk-based (generally guidance) and ARAR-based action levels.

3.2 ARARs AND MEDIA OF CONCERN

3.2.1 ARARs

3.2.1.1 Introduction

The ARARs, which include the requirements, criteria, or limitations promulgated under federal and State law that address a contaminant, action, or location at a site, are presented in this section.

The definition of an ARAR is as follows:

- Any standard, requirement, criterion, or limitation under federal environmental law.
- Any promulgated standard, requirement, criterion, or limitation under a state environmental or facility-citing law that is more stringent than the associated federal standard, requirement, criterion, or limitation.

One of the primary concerns during the development of corrective action alternatives for hazardous waste sites under RCRA is the degree of human health and environmental protection afforded by a given remedy. Consideration should be given to corrective measures that attain or exceed ARARs.

Definitions of the two types of ARARs, as well as TBC criteria, are given below:

- Applicable Requirements means those clean-up standards, standards of control, and other substantive environmental protection requirements, criteria, or limitations promulgated under federal or state law that directly and fully address a hazardous substance, pollutant, contaminant, remedial action, location, or other circumstance at a site.

- Relevant and Appropriate Requirements means those clean-up standards, standards of control, and other substantive environmental protection requirements, criteria, or limitations promulgated under federal or state law that, while not "applicable," address problems or situations sufficiently similar (relevant) to those encountered at the site that their use is well suited (appropriate) to the particular site.

- TBC Criteria are non-promulgated, non-enforceable guidelines or criteria that may be useful for developing corrective measures alternatives and for determining action levels that are protective of human health or the environment.

These requirements are included in order to provide decision makers with a complete evaluation of potential ARARs in developing, identifying, and selecting a corrective measures alternative.

3.2.1.2 ARAR and TBC Categories

ARARs fall into three categories, based on the manner in which they are applied, as follows:

- Chemical Specific: Health-risk-based numerical values or methodologies that establish concentration or discharge limits for particular contaminants. Examples of chemical-specific ARARs include MCLs and Clean Water Act (CWA) Ambient Water Quality Criteria (AWQC). Chemical-specific ARARs govern the extent of site clean-up.

- Location Specific: Restrictions based on the concentrations of hazardous substances or the conduct of activities in specific locations. These may restrict or preclude certain remedial actions or may apply only to certain portions of site. Examples of location-specific ARARs include RCRA location requirements and floodplain management requirements. Location-specific ARARs pertain to special site features.

- Action Specific: Technology- or activity-based controls or restrictions on activities related to management of hazardous waste. Action-specific ARARs pertain to implementing a given remedy.

Table 3-1 presents a summary of potential federal and State ARARs and TBCs for corrective measures undertaken at Site 6A, Site 10B, and the on-site portion of the Southern Area at NWIRP Calverton.

3.2.1.3 Chemical-Specific ARARs and TBCs

This section presents a summary of federal and State chemical-specific ARARs of potential concern in the case of Sites 6A and 10B and the on-site portion of the Southern Area. The ARARs provide medium-specific guidance on "acceptable" or "permissible" concentrations of contaminants.

The Safe Drinking Water Act (SDWA) promulgated National Primary Drinking Water Standard MCLs (40 CFR Part 141). MCLs are enforceable standards for contaminants in public drinking water supply systems. They consider not only health factors but also the economic and technical feasibility of removing a contaminant from a water supply system. Secondary MCLs (40 CFR Part 143) are not enforceable but are intended as guidelines for contaminants that may adversely affect the aesthetic quality of drinking water, such as taste, odor, color, and appearance, and may deter public acceptance of drinking water provided by public water systems.

The SDWA also established Maximum Contaminant Level Goals (MCLGs) for several organic and inorganic compounds in drinking water. MCLGs indicate the level of contaminants in drinking water at which no known or anticipated health effects would occur, allowing for an adequate margin of safety. MCLGs are non-enforceable public health goals.

Tables 3-2 and 3-3 provide federal SDWA requirements that may be applicable to remedial actions involving groundwater at Sites 6A and 10B/Southern Area, respectively. Drinking water standards will also be considered as discharge criteria for alternatives which include groundwater treatment.

The CWA sets EPA AWQC that are non-enforceable guidelines developed for pollutants in surface waters pursuant to Section 304(a)(1) of the CWA. Although AWQC are not legally enforceable, they should be considered as potential ARARs. AWQC are available for the protection of human health from exposure to contaminants in surface water as well as from ingestion of aquatic biota and for the protection of freshwater and saltwater aquatic life. AWQC may be considered for actions that involve groundwater treatment and/or discharge to nearby surface waters.

EPA Generic Soil Screening Levels (SSLs) are guidance values that provide soil concentrations for protection of human health and for migration to groundwater. SSLs are risk-based concentrations derived from equations combining exposure information assumptions with EPA toxicity data. SSLs for protection of groundwater use a simple linear equilibrium soil/water partition equation or leach test to estimate contaminant releases in soil leachate.

Reference Dose (RfD), as defined in the EPA Integrated Risk Information System (IRIS), is an estimate (with uncertainty spanning perhaps an order of magnitude) of a daily exposure to the human population (including sensitive subgroups) that is likely to be without an appreciable risk of deleterious effects during a lifetime. RfDs are developed for chronic and/or subchronic human exposure to hazardous chemicals and are based on the assumption that thresholds exist for certain toxic effects. The RfD is usually expressed as an acceptable dose (mg) per unit body weight (kg) per unit time (day). The RfD is derived by dividing the no-observed-adverse-effect level (NOAEL) or the lowest-observed-adverse-effect level (LOAEL) by an uncertainty factor (UF) times a modifying factor (MF).

EPA Cancer Slope Factor (CSF), as defined in the IRIS, is an upper bound, approximating a 95-percent confidence limit, on the increased cancer risk from a lifetime exposure to a chemical. This estimate, usually expressed in units of proportion (of a population) affected per mg/kg/day, is generally reserved for use in the low-dose region of the dose-response relationship, that is, for exposures corresponding to risks less than 1 in 100.

EPA Region III Risk-Based Concentrations (RBCs) are medium-specific (water, air, fish tissue, and soil) screening levels that were calculated using equations combining exposure information assumptions with EPA toxicity data for a target Hazard Quotient (HQ) of 1.0 for noncarcinogenic effects and a target risk of 1.0×10^{-6} for carcinogenic effects. RBCs have several important limitations. Specifically excluded from consideration are (1) transfers from soil to air, (2) cumulative risk from multiple contaminants or media, and (3) dermal risk. Additionally, the risks for inhalation of vapors from water are based on a very simple model, whereas detailed risk assessments may use more detailed showering models. In general, EPA does not recommend that RBCs be used to set cleanup or no-action levels at CERCLA sites or RCRA corrective action sites.

The Clean Air Act (CAA) [42 United States Code (USC) 7401] consists of three programs or requirements that may be ARARs: National Ambient Air Quality Standards (NAAQSs) (40 CFR Parts 50 and 53), National Emission Standards for Hazardous Air Pollutants (NESHAPs) (40 CFR Part 61), and New Source

Performance Standards (NSPSs) (40 CFR Part 60). NESHAPs, which are emission standards for source types (i.e., industrial categories) that emit hazardous air pollutants, are not likely to be applicable or relevant and appropriate for NWIRP because they were developed for a specific source. EPA requires the attainment and maintenance of primary and secondary NAAQSs to protect public health and public welfare, respectively. These standards are not source specific but rather are national limitations on ambient air quality. States are responsible for assuring compliance with NAAQSs. NSPS are established for new sources of air emissions to ensure that the new stationary sources minimize emissions. These standards are for categories of stationary sources that cause or contribute to air pollution that may endanger public health or welfare. Standards are based upon the best-demonstrated available technology (BDAT).

RCRA Subtitle C Hazardous Waste Identification and Listing (40 CFR Part 261) requirements are used to identify a material that is a hazardous waste and thus determine applicability or relevance of RCRA Subtitle C hazardous waste rules.

New York Ambient Air Quality Standards (6 NYCRR Parts 256 and 257) provide four general classifications of social and economic development and resulting pollution potential upon which standards are based. In addition, air quality standards are established to provide protection from adverse health effects of air contamination and to protect and conserve natural resources and the environment. Part 256 provides the air quality classification standards. The NWIRP is probably classified as Level II (predominantly single and two family residences, small farms, and limited commercial services and industrial development). Part 257 provides air quality standards for regulated contaminants, which include sulfur dioxide, particulates, carbon monoxide, photochemical oxidants, non-methane hydrocarbons, nitrogen dioxide, fluorides, beryllium, and hydrogen sulfide.

New York Public Water Supply Regulations (10 NYCRR Part 5) provide requirements for State public water supplies. Refer to Tables 3-2 and 3-3 for standards applying to NWIRP Site 6A and Site 10B/Southern Area compounds, respectively.

New York Water Classifications and Quality Standards (6 NYCRR Parts 609 and 700 to 705) regulate reclassification of water based on use and value, including protection and propagation of fish, shellfish and wildlife, recreation in and on the water, public water supplies, and agricultural, industrial and other purposes including navigation. Additionally, these standards regulate the discharge of sewage, industrial waste, or other wastes so as not to cause impairment of the best usages of the receiving water as specified by the water classifications at the location of discharge that may be affected by such discharge. Both quantitative standards as well as narrative water quality standards (turbidity, solids, oil, etc.) are provided. (See action-specific ARARs for Groundwater Effluent Standards that would be applicable for alternatives including reinjection to the aquifer).

Part 701 provides the classification of surface water and groundwater. Groundwater beneath the NWIRP would be classified as Class GA. Groundwater quality standards (Class GA) for Site 6A and Site 10B/Southern Area are provided in Tables 3-2 and 3-3, respectively. Also for GA groundwater, pH shall be between 6.5 and 8.5 and total dissolved solids (TDS) shall not exceed 500 mg/L.

New York Technical and Operational Guidance Series (TOGS), Division of Water (TOGS 1.1.1) provides a compilation of ambient water quality guidance values and groundwater effluent limitations for use where there are no regulatory ambient water quality standards (in 6 NYCRR 703.5) or effluent limitations (in 6 NYCRR 703.6). For the convenience of the user, the standards in 703.5 and the limitations in 703.6 are included in this document. The guidance values are appropriate for actions involving groundwater plume remediation and reinjection of treated groundwater into the aquifer.

New York Technical and Administrative Guidance Memorandum on Determination of Soil Cleanup Objectives and Cleanup Levels (TAGM 4046) provides a basis and procedure to determine soil cleanup levels. Soil cleanup objectives are based on human health-based levels that correspond to excess lifetime cancer risks, human health based levels for systemic toxicants calculated from RfDs, environmental concentrations that are protective of groundwater/drinking water quality based on promulgated or proposed New York State Standards, background values for contaminants, or detection limits. Cleanup objectives should be greater than method detection limits (MDLs) and preferably greater than contract required quantification limits (CRQLs). Table 3-4 provides soil cleanup objectives for Site 6A contaminants. Petroleum contamination has been identified in Site 10B soil through TPH DRO analysis; however, no individual contaminants were identified through the analysis. Therefore, no specific soil cleanup objectives are provided for Site 10B soil. For the protection of groundwater quality, concentrations are based on a total organic content of 1 percent. Soil cleanup objectives are limited to the following maximum values: total VOCs less than or equal to 10 ppm, total SVOCs less than or equal to 500 ppm, individual SVOCs less than or equal to 50 ppm, and total pesticides less than or equal to 10 ppm. In addition, soil cannot exhibit a discernible odor nuisance.

New York Spill Technology and Remediation Series (STARS), Petroleum-Contaminated Soil Guidance (STARS Memo #1) is intended as a guidance in determining whether petroleum-contaminated soils have been contaminated to levels that require investigation and remediation. In addition, if the petroleum-contaminated soil contaminant concentrations meet the criteria provided, the soil can be reused or disposed as directed in this guidance (beneficial use). Soils that meet beneficial use conditions are no longer a solid waste as regulated by 6 NYCRR Part 360. This guidance applies to petroleum-contaminated soils that are not considered a characteristic hazardous waste as regulated by 6 NYCRR Part 371 [i.e., Toxicity Characteristic Leaching Procedure (TCLP) results less than or equal to the TCLP Extraction Guidance Values or contaminant concentrations in soil less than TCLP Alternative Guidance Values]. Guidelines for protection of groundwater (TCLP Extraction Guidance Values and Alternative Guidance Values), protection of human health (Human Heath Guidance Values), and protection against objectionable nuisance characteristics are provided. Guidance Values are provided for primary gasoline and fuel oil components of concern. If the soil does not exhibit petroleum-type odors and does not contain any individual contaminant at greater than 10,000 parts per billion (ppb), the soil is considered acceptable for nuisance characteristics. Guidance is also provided for management of excavated (ex situ) and non-excavated (in situ) contaminated soil. TCLP Alternative Guidance Values and Human Health Guidance Values are presented in Table 3-4 for Site 6A soil contaminants. Per previous discussions with NYSDEC, the TAGM 4046 guidance values are to be used in lieu of STARS Memo #1 values; however, the STARS Memo #1 values are provided in the table for informational purposes.

3.2.1.4 Location-Specific ARARs and TBCs

This section presents a summary of federal and State location-specific ARARs of potential concern for Sites 6A and 10B. These potential ARARs and TBCs are as follows:

Federal Protection of Wetlands Executive Order (E.O.) (E.O. 11990) requires federal agencies, in carrying out their responsibilities, to take action to minimize the destruction, loss, or degradation of wetlands and to preserve and enhance the natural and beneficial values of wetlands (unless there is no practical alternative to that construction), to minimize the harm to wetlands (if the only practical alternative requires construction in the wetlands), and to provide early and adequate opportunities for public review of plans involving new construction in wetlands. Corrective measures for Site 6A will probably not impact regulated wetland areas; however, corrective measures for Site 10B and the Southern Area may impact regulated wetland areas. Several ponds, which are considered wetlands, are located adjacent to Site 10B and within the Southern Area.

The Endangered Species Act of 1978 (16 USC 1531) (50 CFR Part 17) provides for consideration of the impacts on endangered and threatened species and their critical habitats. Corrective measures actions, if required, would need to be conducted in a manner such that the continued existence of any endangered or threatened species is not jeopardized or its critical habitat is not adversely affected. Consultation with the United States Fish and Wildlife Service is also required. There are no endangered or threatened species known to reside at or near Sites 6A or the 10B/Southern Area. However, migrating species may move through the area.

The Fish and Wildlife Coordination Act (16 USC 661) provides for consideration of the impacts on wetlands and protected habitats. The act requires that federal agencies, before issuing a permit or undertaking federal action for the modification of any body of water, consult with the appropriate state agency exercising jurisdiction over wildlife resources to conserve those resources. Consultation with the United States Fish and Wildlife Service is also required.

Federal Floodplains Management Executive Order (E.O. 11988) provides for consideration of floodplains during corrective actions. This Executive Order requires that activities be conducted to avoid, to the extent possible, the long- and short-term adverse impacts associated with the occupation or modification of floodplains. Floodplain development should be avoided whenever there are practicable alternatives and should minimize potential harm to floodplains when there are no practical alternatives. Sites 6A and 10B and the On-Site portion of the Southern Area are not within the 100-year floodplain of the Peconic River.

The Archaeological and Historic Preservation Act (16 USC Section 469) (36 CFR Part 65) establishes requirements relating to potential loss or destruction of significant scientific, historical, or archaeological data as a result of any proposed remedy. The Secretary of the Interior must be notified if a federal agency finds that its activities, in connection with any federal construction project, might cause loss or destruction of such data. No historic artifacts are expected to be uncovered at Sites 6A or 10B or the On-Site portion of the Southern Area.

New York Freshwater Wetlands Act [Environmental Conservation Law (ECL) Article 24 and Title 23 of Article 71 of the New York Environmental Conservation Law] regulates activities within wetlands. New York Freshwater Wetlands Regulations (6 NYCRR Parts 662 to 664) provide regulations to preserve, protect, and conserve freshwater wetlands and regulate use and development of the wetlands. Activities within or adjacent to a wetland with an area of at least 12.4 acres or, if smaller, unusual local importance as determined by the State, require a permit or letter of approval. The adjacent area is considered the area within 100 feet of the wetland. Wetlands are classified according to the benefit of the wetlands, with Class I wetlands being the most beneficial and Class IV being the least beneficial. Corrective measures for Site 6A will probably not impact regulated wetland areas; however, corrective measures for Site 10B may impact regulated wetland areas. Several ponds, which are considered wetlands, are located adjacent to Site 10B and within the Southern Area.

New York Endangered and Threatened Species of Fish and Wildlife; Species of Special Concern (6 NYCRR Part 182) provides a list of regulated species. A State endangered species (*Ambystoma tigrinum*, tiger salamander) has been confirmed at the NWIRP Calverton but not at Sites 6A or 10B/Southern Area. This species is a State-regulated species but is not federally regulated (Natural Resources Management Plan, 1989). A permit or license is required to take, import, transport, possess, or sell any endangered or threatened species.

New York Regulation for Administration and Management of the Wild, Scenic, and Recreational Rivers System in New York State Excepting the Adirondack Park (6 NYCRR Part 666) is authorized under the New

York Wild, Scenic, and Recreational Rivers System Act (Title 27 of Article 15 of the New York Environmental Conservation Law) and provides regulations for the management, protection, enhancement, and control of land use and development in river areas on all designated wild, scenic, and recreational rivers (except within the Adirondack Park). The Peconic River and some of its tributaries are classified as a scenic river. Certain kinds of activities and developments within the defined river corridor are restricted or require a permit. Any new direct discharge of any substance into a scenic river must meet water quality standards, (6 NYCRR Parts 701 and 702). Corrective measures for Sites 6A and 10B and the Southern Area may affect the Peconic River.

Fish and Wildlife Impact Analysis for Inactive Hazardous Waste Sites Guidance (Division of Fish and Wildlife, NYSDEC, July 18, 1991) provides guidance for the evaluation of fish and wildlife concerns associated with the remediation of inactive hazardous waste sites. This guidance provides the required elements for a complete impact analysis including site description, contaminant-specific impact analysis, ecological effects of remedial alternatives, implementation of selected alternatives in design, and monitoring program.

3.2.1.5 Action-Specific ARARs and TBCs

This section presents a summary of federal and State action-specific ARARs of potential concern in the case of Sites 6A and 10B and the Southern Area. The potential ARARs and TBCs are as follows:

RCRA Subtitle C regulates the treatment, storage, and disposal of hazardous waste from its generation until its ultimate disposal. In general, RCRA Subtitle C requirements for the treatment, storage, or disposal of hazardous waste will be applicable if:

- The waste is a listed or characteristic waste under RCRA.
- The waste was treated, stored, or disposed (as defined in 40 CFR 260.10) after the effective date of the RCRA requirements under consideration.
- The activity at the site constitutes current treatment, storage, or disposal as defined by RCRA.

RCRA Subtitle C requirements may be relevant and appropriate when the waste is sufficiently similar to a hazardous waste and/or the on-site corrective action constitutes treatment, storage, or disposal and the particular RCRA requirement is well suited to the circumstances of the contaminant release and site. RCRA Subtitle C requirements may also be applicable when the corrective action constitutes generation of a hazardous waste.

The following requirements included in the RCRA Subtitle C regulations may pertain to the NWIRP Calverton:

- Hazardous waste identification and listing regulations (40 CFR Part 261).
- Hazardous waste generator requirements (40 CFR Part 262).
- Transportation requirements (40 CFR Part 263).
- Standards for owners and operators of hazardous waste treatment, storage, and disposal (TSD) facilities (40 CFR Part 264).
- Interim status standards for owners and operators of hazardous waste TSD facilities (40 CFR Part 265).
- Land disposal restrictions (LDRs) (40 CFR Part 268).

Hazardous Waste Identification and Listing Regulations (40 CFR Part 261) define those solid wastes that are subject to regulation as hazardous waste under 40 CFR Parts 262 to 265 and Parts 124, 270, and 271.

A generator that treats, stores, or disposes of hazardous waste on site must comply with RCRA Standards Applicable to Generators of Hazardous Waste (40 CFR Part 262). These standards include manifest, pre-transport (i.e., packaging, labeling, and placarding), record keeping, and reporting requirements. The standards are applicable if actions taken at Sites 6A or 10B or the Southern Area constitute generation of a hazardous waste (e.g., generation of water treatment residues or excavation of contaminated soils and/or sediments that may be hazardous).

Standards Applicable to Transporters of Hazardous Waste (40 CFR Part 263) are applicable to off-site transportation of hazardous waste. These regulations include requirements for compliance with manifest and record keeping systems and requirements for immediate action and clean-up of hazardous waste discharges (spills) during transportation. The standards are potentially applicable if corrective actions involve off-site transportation of hazardous waste from Sites 6A and 10B and the Southern Area.

Standards and Interim Status Standards for Owners and Operators of Hazardous Waste Treatment, Storage, and Disposal (TSD) Facilities (40 CFR Parts 264 and 265) are applicable to corrective actions that may be taken at Sites 6A or 10B/Southern Area and to off-site facilities that receive hazardous waste from the site for treatment and/or disposal. Standards for TSD facilities include requirements for preparedness and prevention, corrective action requirements, closure and post-closure care, use and management of containers, and design and operating standards for tank systems, surface impoundments, waste piles, landfills, and incinerators. These standards are potentially applicable if corrective actions involve the on-site treatment or disposal of hazardous waste at Sites 6A or 10B or the Southern Area.

RCRA LDR Requirements (40 CFR Part 268) restrict certain wastes from being placed or disposed on the land unless they meet specific BDAT treatment standards (expressed as concentrations, total or in the

TCLP extract, or as specified technologies). Removal and treatment of a RCRA hazardous waste or movement of the waste outside of a Corrective Action Management Unit (CAMU), thereby constituting "placement" would trigger the land disposal restriction (LDR) requirements.

Placement of hazardous waste into underground injection wells constitutes "land disposal" under the LDRs. Furthermore, RCRA Section 3020(a) bans hazardous waste disposal by underground injection into or above an underground source of drinking water. RCRA Section 3020(b), however, exempts from the ban all reinjection of treated contaminated groundwater into such formations undertaken as part of a RCRA corrective action. The contaminated groundwater must be treated to substantially reduce hazardous constituents before such injection, and the corrective action must be sufficient to protect human health and the environment upon completion. LDRs would be potentially applicable if corrective actions at Sites 6A and 10B and the Southern Area include off-site disposal of wastes in a landfill or reinjection of treated groundwater.

RCRA Corrective Action Management Units and Temporary Units, Final Rule (40 CFR Parts 260, 264, 265, 268, 270, and 271) addresses two new units, CAMUs and temporary units (TUs), under RCRA corrective action authorities. These special provisions were proposed as part of a more comprehensive rulemaking on July 27, 1990. The final regulations became effective on April 19, 1993 and were amended on November 30, 1998 to include staging piles.

When a site, or portion of a site, receives a CAMU designation, the designated area qualifies for certain exemptions from RCRA Subtitle C requirements. LDRs are not triggered when hazardous remediation waste is placed in a CAMU, when remediation wastes generated at a facility outside a CAMU are consolidated into a CAMU, or when remediation wastes are moved between two or more CAMUs. In addition, remediation wastes can be excavated from a CAMU, treated in a separate unit, and redeposited in the CAMU without triggering LDRs. TUs are containers and tanks used on a temporary basis. TUs and staging piles may be subject to reduced minimum technology standards and closure requirements. This rule may be applicable or relevant and appropriate for on-site handling and disposal of soil at Sites 6a and 10B.

RCRA Subtitle D includes guidelines for regional solid waste plans, design and operating criteria for solid (non-hazardous) waste landfills, and upgrading of open dumps.

RCRA Criteria for Classification of Solid Waste Disposal Facilities and Practices (40 CFR Part 257) establish criteria for use in determining which solid waste disposal facilities and practices pose a reasonable probability of adverse effects on health and thereby constitute prohibited open dumps.

Department of Transportation (DOT) Rules for Hazardous Materials Transport (49 CFR Parts 107 and 171 to 179) regulate the transport of hazardous materials, including packaging, shipping equipment, and placarding. These rules are considered applicable to wastes shipped off site for laboratory analysis, treatment, or disposal.

The National Environmental Policy Act (NEPA) (42 USC 4321 et seq) and implementing regulations (40 CFR Part 6) require federal agencies to evaluate the environmental impacts associated with major actions that they fund, support, permit, or implement.

The CWA, as amended, governs point-source discharges through the National Pollutant Discharge Elimination System (NPDES), discharge of dredge or fill material, and oil and hazardous waste spills to United States waters. NPDES requirements (40 CFR Part 122) will be applicable if the direct discharge of pollutants into surface waters is part of the corrective action (i.e., discharge of effluent from a groundwater treatment system). These regulations contain discharge limitations, monitoring requirements, and best management practices.

Toxic Substances Control Act (40 CFR Part 761.60-761-79 Subpart D Storage and Disposal) specifies treatment, storage, and disposal requirements for PCBs based on the PCB concentration of the original material. Specifically, remediation for non-liquid (soil, rags, and debris) exceeding 50 parts per million (ppm) is addressed in 40 CFR Section 761.6. Remediation for these non-liquids consists of incineration (in accordance with 761.70), chemical waste landfill (in accordance with 761.75), or an alternative treatment method attaining the same performance as incineration (typically 2 ppm measured in the treated residual).

Control of Air Emissions from Superfund Air Strippers at Superfund Groundwater Sites [Office of Solid Waste and Emergency Response (OSWER) Directive 9355.0-28] is a TBC that guides the control of air emissions from air strippers. For sites located in areas that are not attaining NAAQSs for ozone, add-on emission controls are required for an air stripper with an actual emission rate in excess of 3 pounds per hour, an actual emission rate in excess of 15 pounds per day, or a potential (i.e., calculated) emission rate of 10 tons per year of total VOCs. Generally, the guidelines are suitable for VOC air emissions from other vented extraction techniques (e.g., soil vapor extraction) but not from area sources (e.g., soil excavation). NWIRP Calverton is in a nonattainment area for ozone.

General Pretreatment Regulations for Existing and New Sources of Pollutants (40 CFR Part 403) controls the indirect discharge of pollutants to publicly owned treatment works (POTWs). The goal of the pretreatment program is to protect municipal wastewater treatment plants and the environment from damage that may occur when hazardous, toxic, or other non-domestic wastes are discharged in a sewer system. The regulations include general and specific prohibitions on discharges to POTWs. The regulations are potentially applicable if treated or untreated groundwater is discharged to a local POTW.

Underground Injection Control Program (40 CFR Parts 144 and 147) contains provisions for the control and prevention of pollutant injection into groundwater. Class IV wells are used to inject hazardous waste into or above a formation that, within ¼ mile of the well, contains an underground drinking water source. Operation or construction of Class IV wells is prohibited and allowed only for the reinjection of treated wastes as part of a CERCLA or RCRA clean-up. The regulations are potentially applicable if groundwater is removed, treated, and reinjected into the formation from which it was withdrawn.

Monitored Natural Attenuation at Superfund, RCRA Corrective Action, and Underground Storage Tank Sites (OSWER Directive 9200.4-17P) contains guidelines for the use of monitored natural attenuation for the remediation of contaminated soil and groundwater. This guidance is a TBC criterion if monitored natural attenuation is a component of the corrective action at Sites 6A and 10B and the Southern Area.

The Occupational Health and Safety Act (29 USC Sections 651 through 678) regulates worker health and safety during implementation of remedial actions.

New York Environmental Conservation Law (New York Consolidated Laws, Chapter 43-B) concerns the conservation, improvement, and protection of State natural resources and environment and controls water, land, and air pollution.

The following requirements included in the ECL in particular may pertain to remedial activities at the NWIRP sites:

- Article 17-Water Pollution Control provides policy to require use of all known available and reasonable methods to prevent and control the pollution of State waters consistent with public health and use, propagation and protection of fish and wildlife, and the industrial development of the State.

- Article 19-Air Pollution Control Act provides policy to maintain the quality of the air resources of the State. Regulations for implementing this act are provided in 6 NYCRR Parts 200 to 257. This act also provides trial burn requirements for burning of hazardous waste.

- Article 27- New York Solid and Hazardous Waste Management Laws address solid and hazardous waste management, including waste transport permits, solid waste management and resource recovery facilities, industrial hazardous waste management, siting of hazardous waste facilities, and inactive hazardous waste disposal sites. A preferred State-wide hazardous management practices hierarchy is also provided (1) reduce or eliminate to the maximum extent practical the generation of hazardous waste, (2) recover, reuse, or recycle to the maximum extent practical generated hazardous waste, (3) utilize detoxification, treatment, or destruction technology for hazardous waste that cannot be reduced, recovered, reused or recycled, and (4) land disposal of industrial hazardous waste, except treated residuals posing no significant threat to the public health or environment. Special provisions for land burial and disposal in Nassau and Suffolk Counties are provided. No new landfills (or expansions to existing landfills) are allowed in a deep flow recharge area. For new landfills outside a deep flow recharge area, hazardous waste is prohibited and the landfill can only accept material that is a product or resource recovery, incineration or composting. Regulations to implement these laws are included in 6 NYCRR Parts 360 to 483.

- Article 70-Uniform Procedures establish uniform review procedures for major regulatory programs of the NYSDEC and establishes time periods for NYSDEC action on permits under such programs. Procedures are provided for coordinating permitting for a project requiring one or more NYSDEC permit.

New York Air Pollution Control Regulations (6 NYCRR Parts 200 to 257) regulate emissions from specific sources. Part 212, General Process Emission Sources, provides general requirements. NWIRP is located in Suffolk County, which is considered part of the New York City Metropolitan Area. The degree of air cleaning required for the different contaminant ratings are as follows. For the most stringently rated contaminants (Rating A), for emission rate potentials greater than 1 pounds per hour, 99 percent or more removal or best available control technology if required. For emission rate potentials less than 1 pounds per hour, the degree of air cleaning required shall be specified by the State. For Ratings of B, C, or D and for emission rate potentials of 3.5 pounds per hour or less, the degree of air cleaning required shall be specified by the State (Ratings B or C) or no cleaning is required (Rating D). For emission rate potentials greater than 3.5 pounds per hour, reasonably available control technology shall be used. Part 231 regulates new source review for air contamination source projects in non-attainment areas. To be applicable, annual emissions (within a nonattainment area) from the source must exceed the de minimus emission limits. The de minimus emission limit is 40 tons per year for volatile organics and 25 tons per year for particulates.

New York Waste Management Facilities Rules (6 NYCRR Part 360) regulate solid waste management facilities (other than hazardous waste management facilities subject to Parts 373 and 374). Siting requirements for solid waste management facilities include that the facility must not be constructed or operated in such a manner that may have an adverse affect on any endangered or threatened species or their critical habitat and the facility cannot be located within the boundary of a regulated wetland. A permit is required to construct, operate, modify, or expand a solid waste management facility. However, temporary storage, treatment, incineration, and process facilities (including temporary mobile processing facilities) may be exempt from permitting requirements if the facility is located at an industrial or commercial establishment and is used exclusively for solid wastes generated at that location or at a location under the same ownership within a single region of the NYSDEC. The rules specify that excavated petroleum-contaminated soils cannot be stored on site greater than 60 days unless otherwise approved by the NYSDEC. Non-hazardous petroleum-contaminated soil that has been decontaminated and is being used in an acceptable manner is considered beneficial use (this includes incorporation into asphalt pavement by an authorized facility). These rules may be applicable if contaminated soil is stored or landfilled on site.

New York Rules for Siting Industrial Hazardous Waste Facilities (6 NYCRR Part 361) regulate the siting of new industrial hazardous waste facilities located wholly or partially within the State. Evaluation criteria for siting include consideration of population density, transportation route, contamination of groundwater and surface water, air quality, and preservation of endangered, threatened, and indigenous species.

New York Waste Transport Permit Regulations (6 NYCRR Part 364) govern the collection, transport, and delivery of regulated waste originating or terminating at a location within the State. These regulations are potentially applicable if contaminated soils or groundwater treatment residuals are hauled off site for treatment or disposal.

New York General Hazardous Waste Management System Regulations (6 NYCRR Part 370) provide general definitions and set forth State procedures for making information available to the public, confidentiality, petitioning equivalent testing methods, and petitioning for exclusion of a waste from a particular facility. These regulations are potentially applicable if excavated soil or treatment residuals would be classified as a hazardous waste.

New York Identification and Listing of Hazardous Wastes Regulations (6 NYCRR Part 371) establish procedures for identifying solid wastes subject to regulation as hazardous wastes. These regulations would be used to determine whether contaminated soil or treatment residuals meet the definition of a hazardous waste.

New York Hazardous Waste Manifest System Regulations (6 NYCRR Part 372) establishes standards for hazardous waste generators, transporters, and TSD facilities associated with the use of the manifest system and its record keeping requirements. These regulations are potentially applicable if corrective actions involve off-site transportation of hazardous waste.

New York Hazardous Waste Treatment, Storage, and Disposal Facility Permitting Requirements (6 NYCRR Subpart 373-1) regulate hazardous waste management facilities located within the State. These regulations are potentially applicable if corrective actions involve on-site treatment, storage, or disposal of hazardous waste.

New York Final Status Standards for Owners and Operators of Hazardous Waste Treatment, Storage, and Disposal Facilities (6 NYCRR Subpart 373-2) establish minimum State standards that define the acceptable management of hazardous waste. These standards are potentially applicable if corrective actions involve on-site treatment or disposal of hazardous waste at Sites 6A and 10B and the Southern Area.

New York Interim Status Standards for Owners and Operators of Hazardous Waste Facilities (6 NYCRR Subpart 373-3) establish minimum State standards that define the acceptable management of hazardous waste during the period of interim status and until certification of closure. These standards are potentially applicable if corrective actions involve on-site treatment or disposal of hazardous waste.

New York Standards for the Management of Specific Hazardous Wastes and Hazardous Waste Management Facilities (6 NYCRR Part 374-1) contain requirements for generators and transporters of hazardous waste and for owners and operators of facilities managing hazardous wastes. The regulation specifically addresses recyclable materials, hazardous waste or used oil burned for energy recovery, and reclaimed lead-acid batteries. These standards would be potentially applicable in the unlikely event that recyclable hazardous waste materials are used in a manner constituting disposal.

New York Rules for Inactive Hazardous Waste Disposal Sites (6 NYCRR Part 375) apply to the development and implementation of programs to address inactive hazardous waste disposal sites. The goal for a specific site is to restore it to pre-disposal conditions, to the extent feasible and authorized by law. At a minimum, the remedy selected shall eliminate or mitigate significant threats to the public health and the environment. State review and concurrence with the selected remediation scheme is required. The hierarchy of remedial technologies is as follows: destruction, separation/treatment, solidification/chemical fixation, and control and isolation.

New York Land Disposal Restrictions Regulations (6 NYCRR Part 376) identify hazardous wastes that are restricted from land disposal and define limited circumstances under which an otherwise prohibited waste may be land disposed. LDRs would be potentially applicable if corrective actions at Sites 6A and 10B and the Southern Area include land disposal of hazardous waste.

New York Rules on Hazardous Waste Program Fees (6 NYCRR Parts 483) address generator fees, TSD facility fees, and waste transporter fees.

New York Water Classifications and Quality Standards (6 NYCRR Parts 609 and 700 to 706) Parts 700 to 706 provide regulations for the discharge of sewage, industrial waste, or other wastes so as not to cause impairment of the best usages of the receiving water as specified by the water classifications at the location of discharge that may be affected by such discharge. Part 703.6 provides groundwater effluent limitations. Treated groundwater may be reinjected to groundwater and would need to comply with groundwater effluent limitations (see Tables 3-2 and 3-3). The NWIRP site is in Suffolk County and will additionally have to comply with a maximum concentration of 1,000 mg/L TDS and 10 mg/L total nitrogen (as N).

New York Regulations on State Pollutant Discharge Elimination System (6 NYCRR Parts 750 to 758) prescribe procedures and substantive rules concerning discharges to State waters. A State Pollutant Discharge Elimination System (SPDES) permit or NPDES permit is required to discharge to surface water. Amendments to these regulations will be proposed to repeal the current portions of Parts 750 through 758 that have been suspended by other laws and regulations and to renumber the remaining sections to develop a new comprehensive Part 750.

3.3 CORRECTIVE ACTION OBJECTIVES

CAOs are developed in this section to address contaminated soil at Sites 6A and 10B and groundwater at Sites 6A and 10B and the On-Site Southern Area Plume. CAOs generally identify COCs, receptors, pathways, and action levels (Preliminary Remediation Goals [PRGs]). Site- and medium-specific CAOs and corresponding PRGs are presented in the following sections.

The CAOs address the identified environmental risks at Sites 6A and 10B and the Southern Area at NWIRP Calverton. Contaminated soils and groundwater represent a potential threat to human health at the sites through ingestion, dermal contact, and inhalation.

3.3.1 Corrective Action Objectives for Soil

The CAOs for contaminated soils are as follows.

- Prevent human exposure (ingestion, dermal contact, dust inhalation) to contaminated soils with concentrations greater than PRGs.

- Prevent leaching of contaminants at resultant groundwater concentrations in excess of groundwater PRGs.

- Comply with chemical-specific, location-specific, and action-specific ARARs and guidance.

Site 6A

PRGs for the Site 6A COCs are provided in Table 3-4. Also presented in this table are the maximum concentrations of the COCs. It should be noted that there are no specific federal or State standards for soil remediation; however, the recommended soil clean-up objectives in TAGM 4046 were used to develop

PRGs for soil. In general, the lower of the clean-up objective to protect groundwater quality or to protect human health was used as the PRG. For several of the SVOCs, the Practical Quantitation Limit (PQL) is higher than the recommended clean-up objective. In these cases, the detection limit was selected as the PRG. If the selected PRG was based on soil clean-up objective to protect groundwater, it was corrected using a site-specific total organic carbon (TOC) concentration of 0.1 percent (a site-specific value).

As per TAGM 4046, the soil clean-up objectives developed per the guidance should be used in selecting alternatives in the FS. Based on the proposed selected remedial technology (outcome of the FS), final site-specific soil clean-up levels are established in the Statement of Basis (or other decision document). TAGM 4046 also notes that even after final soil clean-up levels are established, these levels may prove to be unattainable, and institutional controls may be necessary.

Site 10B

Fuel-related contamination (soil and trace amounts of free product) was identified as the COC for Site 10B soil. No chemical-specific analyses were performed on soil samples from the site; however, TPH DRO and GRO analyses were performed on 10 soil samples. TPH GRO was not detected in any of the samples, but TPH DRO was detected at a maximum concentration of 8,500 mg/kg in Site 10B soil. Based on this information, it is likely that the fuel-related contamination contains primarily SVOCs and small amounts of VOCs. The following recommended soil clean-up objectives from TAGM 4046 were selected as the PRGs for the soil:

- Individual VOCs and SVOCs less than TAGM 4046 values
- Total VOCs less than 10 mg/kg
- Total SVOCs less than 500 mg/kg
- Individual SVOCs less than 50 mg/kg
- Soil shall not exhibit a discernable odor nuisance

In the future, when chemical-specific soil data are available for Site 10B (prior to completion of the remedial design), the PRG list will be amended and the soil clean-up objectives from TAGM 4046 will be used to develop chemical-specific PRGs for soil. These PRGs will likely be identical to that presented for Site 6A soils.

3.3.2 <u>Corrective Action Objectives for Groundwater</u>

The CAOs for contaminated groundwater for Sites 6a and 10B and the On-Site Southern Area Plume are as follows:

- Prevent human exposure (through ingestion, inhalation, and dermal contact) to groundwater having contaminants at concentrations greater than PRGs.

- Restore contaminated groundwater quality to the PRGs to the maximum extent that is technically feasible.

- Comply with contaminant-specific, location-specific, and action-specific ARARs and guidance.

If groundwater PRGs cannot be achieved or the aquifer cannot be restored, then at a minimum, the following objectives should be met:

- Reduce human exposure (ingestion, inhalation, dermal contact) to groundwater having contaminants at concentrations greater than PRGs.
- Minimize the migration of contaminants that could cause adverse affects on downgradient receptors.

Site 6A

PRGs for Site 6A contaminated groundwater are provided in Table 3-2. Also presented in this table is the maximum concentration detected for each COC. To develop the groundwater PRGs, the most stringent promulgated standard has been utilized, including federal MCLs/MCLGs, New York State MCLs, and New York State groundwater quality standards, for the COCs. Proposed federal standards or New York State guidance were only considered if no other criteria were available. For 4-methylphenol, the proposed standard was less than the PQL; therefore, the PQL was selected for the PRG.

Site 10B/Southern Area

PRGs for Site 10B and On-Site Southern Area Plume contaminated groundwater are provided in Table 3-3. The PRGs were selected following the same process used to select Site 6A PRGs. All of the selected PRGs are greater than PQLs.

TABLE 3-1

SUMMARY OF ARARs AND TBC CRITERIA
SITE 6A, SITE 10B, AND ON-SITE SOUTHERN AREA PLUME
NWIRP, CALVERTON, NEW YORK

Requirement	Citation	Status	Synopsis	Comment
Chemical-Specific ARARs and TBCs				
Federal				
Safe Drinking Water Act (SDWA) Maximum Contaminant Levels (MCLs) Secondary MCLs (SMCLs) MCL Goals (MCLGs)	42 United States Code (USC) 300f et seq. 40 Code of Federal Regulations (CFR) Parts 141 to 143	MCLs are relevant and appropriate; SMCLs and MCLGs are To Be Considered (TBC)	MCLs, SMCLs, and MCLGs established under this act are health-based limits for certain chemical substances in drinking water.	Relevant and appropriate or TBC for determining PRGs. Groundwater was identified as a concern during the investigation.
Clean Water Act (CWA) Ambient Water Quality Criteria (AWQC)	33 USC 1251 et seq. Section 304(a)(1)	TBC	Water-quality criteria are non-enforceable guidance and are used in conjunction with the designed use for a stream segment to establish water quality standards under CWA 303.	During remedial activities, groundwater or treatment by-products may be collected. AWQCs are TBC if this water is discharged to surface waters.
EPA Generic Soil Screening Levels (SSLs)	EPA 540-R-96-018 Appendix A	TBC	Federal guidance that provides screening levels for protection of human health and groundwater from soil contaminants.	TBC for determining Preliminary Remediation Goals (PRGs).
Reference Doses (RfDs) from Integrated Risk Information System	NA	TBC	EPA Office of Research and Development guidelines used in the public health assessment.	TBC for determining PRGs.
Cancer Slope Factors (CSFs)	NA	TBC	EPA Environmental Criteria and Assessment Office; EPA Carcinogen Assessment Group guidelines used in the public health assessment.	TBC for determining PRGs.
Risk-Based Concentrations (RBCs)	EPA Region III, October 1998	TBC	RBCs are screening levels calculated for a target Hazard Quotient of 1.0 for noncarcinogenic effects and a target risk of 1 x 10^{-6} for carcinogenic effects.	TBC for determining PRGs.
Clean Air Act (CAA)	42 USC 7401 et seq.	Relevant and Appropriate	Federal legislation that addresses air pollution control.	Pertinent sections of this act are discussed as follows.
National Ambient Air Quality Standards (NAAQSs)	40 CFR Part 50	Relevant and Appropriate	Non-source specific limitations for ambient air quality.	Any air emission would require appropriate controls to meet NAAQSs.
New Source Performance Standards (NSPSs)	40 CFR Part 60	Relevant and Appropriate	Emission standards established for new sources of air emissions.	Relevant and appropriate if the pollutants emitted and the technology employed (e.g., air stripping) during the clean-up action are sufficiently similar to the pollutant and source category regulated by an NSPS and are well suited to the circumstances at the site.
National Emission Standards for Hazardous Air Pollutants (NESHAPs)	40 CFR Part 61	Not Applicable	Emission standards for source types (i.e., industrial categories) that emit hazardous air pollutants.	Not likely to be applicable or relevant and appropriate because NESHAPs were developed for specific sources.

TABLE 3-1

SUMMARY OF ARARs AND TBC CRITERIA
SITE 6A, SITE 10B, AND ON-SITE SOUTHERN AREA PLUME
NWIRP, CALVERTON, NEW YORK

Requirement	Citation	Status	Synopsis	Comment
Chemical-Specific ARARs and TBCs (Continued)				
Federal (Continued)				
Resource Conservation and Recovery Act (RCRA) Subtitle C – Hazardous Waste Identification and Listing Regulations	40 CFR Part 261	Applicable	These rules are used to identify a material as a hazardous waste, and thus determine applicability or relevance of RCRA Subtitle C hazardous waste management requirements.	Alternative implementation may involve excavating soils, which may exceed Toxicity Characteristics Leaching Procedure (TCLP) criteria. If so, management of these contaminated soils should be conducted in compliance with RCRA requirements.
State				
New York Ambient Air Quality Standards	6 New York State Department of Environmental Conservation Rules and Regulations (NYCRR) Parts 256 and 257	Applicable	Regulations for the control and prevention of air pollutants. The NWIRP site area is classified as Level II.	Particulate and non-methane hydrocarbon standards will be applicable to the site.
New York Public Water Supply Regulations	10 NYCRR Part 5	Applicable	Drinking water quality standards for New York	Drinking water standards impact selection of groundwater remediation goals, as well as treatment goals for reinjection of treated effluent to the aquifer.
New York Water Classifications and Quality Standards	6 NYCRR Parts 609 and 700 to 705	Applicable	Regulations for the control and prevention of water pollutants. NWIRP site is in Suffolk County with groundwater classified as GA, requiring reinjected groundwater to have a maximum concentration of 1,000 mg/L Total Dissolved Solids (TDS) and 10 mg/L total nitrogen. Provides a compilation of ambient water quality guidance values and groundwater effluent limitations for use when there are no regulatory standards and limitations.	Standards applicable for actions involving the selection of groundwater plume remediation goals as well as treatment goals for reinjection of treated effluent to the aquifer.
New York Technical and Operational Guidance Series (TOGS), Division of Water	TOGS 1.1.1	TBC	Provides a compilation of ambient water quality guidance values and groundwater effluent limitations for use when there are no regulatory standards and limitations.	TBC for actions involving groundwater plume remediation.
New York Technical and Administrative Guidance Memorandum (TAGM) 4046 on Determination of Soil Cleanup Objectives and Cleanup Levels	TAGM 4046	TBC	Provides a basis and procedure to determine soil clean-up levels.	TBC if alternative implementation involves excavating soils.
New York Spill Technology and Remediation Series (STARS), Petroleum-Contaminated Soil Guidance	STARS Memo # 1	TBC	Provides criteria to determine whether petroleum-contaminated soils require remediation and whether the soils meet beneficial use conditions.	TBC for NWIRP Sites 6A and 10B, which have petroleum- contaminated soils.

TABLE 3-1

SUMMARY OF ARARs AND TBC CRITERIA
SITE 6A, SITE 10B, AND ON-SITE SOUTHERN AREA PLUME
NWIRP, CALVERTON, NEW YORK

Requirement	Citation	Status	Synopsis	Comment
Location-Specific ARARs and TBCs				
Federal				
Federal Protection of Wetlands Executive Order	Executive Order (E.O.) 11990	Not Applicable	Requires the action of federal agencies to minimize the destruction, loss, or degradation of wetlands and preserve and enhance the natural and beneficial values of wetland.	Wetlands are located at or adjacent to Site 10B/Southern Area that may be impacted by corrective actions.
Endangered Species Act of 1978	16 USC 1531 50 CFR Part 17	Potentially Applicable	Requires federal agencies to ensure that any action authorized, funded, or carried out by the agency is not likely to jeopardize the future existence or critical habitat of any endangered or threatened species.	No endangered or threatened species are known to permanently reside in the vicinity of NWIRP. However, migrating species may occasionally move through the area.
Fish and Wildlife Coordination Act	16 USC 661	Not Applicable	Provides for consideration of the impacts on wetlands and protected habitats.	Wetlands are located at or adjacent to Site 10B/Southern Area that may be impacted by corrective actions.
Federal Floodplains Management Executive Order	E.O. 11988	Not Applicable	Provides for consideration of floodplains during corrective actions.	Sites 6A and 10B and the On-Site Southern Area are not within the 100-year floodplain of the Peconic River.
Archaeological and Historic Preservation Act	16 USC 469 36 CFR 65	Potentially Applicable	Prior to site activities as well as during excavation, actions must be taken to identify, recover, and preserve artifacts.	No historic artifacts are expected to be uncovered in the vicinity of Sites 6A and 10B, and the Southern Area; however, artifacts may be discovered during site work.
State				
New York Freshwater Wetlands Act and New York Freshwater Wetlands Regulations	Environmental Conservation Law (ECL) Article 24 and Title 23 of Article 71 6 NYCRR Parts 662 to 664	Potentially Applicable	Activities within or adjacent to State-regulated wetlands requires a permit or letter of approval. Adjacent area is considered the area within 100 feet of the wetlands.	Wetlands are located at or adjacent to Site 10B/Southern Area that may be impacted by corrective actions.
New York Endangered and Threatened Species of Fish and Wildlife; Species of Special Concern	6 NYCRR Part 182	Potentially Applicable	A permit or license is required to take, import, transport, possess, or sell any endangered or threatened species.	A State endangered species has been confirmed at NWIRP, although not at Sites 6A or 10B or the Southern Area.
Regulation for Administration and Management of the Wild Scenic and Recreational Rivers System in New York State Excepting Adirondack Park	6 NYCRR Part 666	Potentially Applicable	Certain kinds of activities and developments within the defined river corridor are restricted or require a permit.	The Peconic River and some of its tributaries are classified as a scenic river. Corrective measures at Sites 6A and 10B and the On-Site Southern Area may affect the Peconic River.
Fish and Wildlife Impact Analysis for Inactive Hazardous Waste Site Guidance	Division of Fish and Wildlife, NYSDEC July 18, 1991	TBC	Provides guidance for the evaluation of fish and wildlife concerns associated with the remediation of inactive hazardous waste sites.	Considered during the evaluation of corrective measure alternatives.

TABLE 3-1

SUMMARY OF ARARs AND TBC CRITERIA
SITE 6A, SITE 10B, AND ON-SITE SOUTHERN AREA PLUME
NWIRP, CALVERTON, NEW YORK

Requirement	Citation	Status	Synopsis	Comment
Action-Specific ARARs and TBCs				
Federal				
RCRA Subtitle C	42 USC 6921 et seq.	Potentially Applicable	Establishes design and operating criteria for hazardous waste landfills.	Potentially applicable if soil is determined to be hazardous.
Identification and Listing of Hazardous Waste	40 CFR Part 261	Potentially Applicable	Regulations that govern the procedures for identifying if a material is a hazardous waste.	Specific materials at the site may be classifiable as a listed hazardous waste.
RCRA Standards Applicable to Generators of Hazardous Waste	40 CFR Part 262	Potentially Applicable	Regulations with which a generator that treats, stores, or disposes of hazardous waste on site must comply.	Applicable for removed wastes determined to be hazardous.
Standards Applicable to Transporters of Hazardous Waste	40 CFR Part 263	Potentially Applicable	Regulations for the manifest and record keeping systems and for the immediate action and cleanup of hazardous waste discharges (spills) during transportation.	Applicable for removed wastes determined to be hazardous that is transported off site.
Standards and Interim Standards for Owners and Operators of Hazardous Waste Treatment Storage, and Disposal (TSD) Facilities	40 CFR Part 264 and 265	Potentially Applicable	Regulations that govern the treatment, storage, and disposal of hazardous waste.	These regulations would be applicable to waste removed from this site including both on-site and off-site management; however, the reuse of treated soils as backfill would not be subject to the disposal facility standard.
Toxic Substances Control Act (TSCA)	40 CFR Part 761	Potentially Applicable	Regulations that govern treatment, storage, and disposal of PCB-contaminated waste.	These regulations would be applicable to excavated soils at Site 6A that contain PCBs at concentrations greater than 50 ppm.
Land Disposal Restrictions (LDRs)	40 CFR Part 268	Potentially Applicable	Regulations that govern the treatment and disposal of certain hazardous waste.	Treatment or disposal of contaminated soils/ wastes and/or treatment residuals may be considered hazardous waste subject to land disposal restrictions.
Corrective Action Management Units and Temporary Units (CAMU), Final Rule	40 CFR Parts 260, 264,265,268,270, and 271	Potentially Applicable	CAMU designated areas qualify for certain exemptions from RCRA Subtitle C requirements. Particularly, remediation wastes can be moved between sites within the designated area and can be treated and replaced without triggering LDRs.	Site work at NWIRP may involve the use of CAMUs.
RCRA Subtitle D	40 USC 6941 et seq.	Potentially Applicable	Establishes design and operating criteria for solid waste (non-hazardous) landfills.	Potentially applicable if soil is determined to be nonhazardous.
RCRA Criteria for Classification of Solid Waste Disposal Facilities and Practices	40 CFR Part 257	Potentially Applicable	Criteria to determine which solid waste disposal facilities pose a probability of adverse health effects and therefore prohibit open dumps.	Applicable if soil is stockpiled or disposed on site.
Department of Transportation (DOT) Rules for Hazardous Materials Transport	49 CFR Parts 107 and 171 to 179	Potentially Applicable	Regulations for the transportation of hazardous materials. Requirements cover packaging, marking, labeling, and transportation methods.	Off-site shipments of any contaminated soil that is classified as a hazardous material from this site would have to comply with these regulations.
National Environmental Policy Act (NEPA)	42 USC 4321 40 CFR Part 6	Potentially Applicable	Requires federal agencies to evaluate the environmental impacts associated with major actions that they fund, support, permit, or implement.	Alternatives could constitute significant activities, thereby making NEPA requirements Applicable or Relevant and Appropriate Requirements (ARARs).

SUMMARY OF ARARs AND TBC CRITERIA
SITE 6A, SITE 10B, AND ON-SITE SOUTHERN AREA PLUME
NWIRP, CALVERTON, NEW YORK

Requirement	Citation	Status	Synopsis	Comment
Action-Specific ARARs and TBCs (Continued)				
Federal (Continued)				
CWA – National Pollution Discharge Elimination System (NPDES)	40 CFR Part 122	Potentially Applicable	Regulations for discharge, dredge, or fill materials and oil or hazardous waste spills into United States waters.	These requirements are applicable for all alternatives that include a discharge to surface water.
Control of Air Emission from Superfund Air Strippers at Superfund Sites	Office of Solid Waste and Emergency Response (OSWER) Directive 9355.0-28	TBC	Guidelines for control of air emissions from air strippers at Superfund groundwater remediation sites.	Restoration at Site 6A and Site 10B and the Southern Area may include air stripping and/or vapor extraction of groundwater and is in a NAAQS ozone nonattainment area.
General Pretreatment Regulations for Existing and New Sources of Pollutants	40 CFR Part 403	Potentially Applicable	Regulations for pretreatment of contaminated water prior to discharge to a Publicly-Owned Treatment Works (POTW).	Effluent from a groundwater treatment system at Site 6A and Site 10B and the Southern Area may be discharged to a local POTW.
Underground Injection Control Program	40 CFR Parts 144 and 147	Potentially Applicable	Regulations for the control and prevention of pollutants injection into groundwater.	Effluent from treatment of groundwater may be reinjected (Class IV well) into the same formation from which it was withdrawn.
Monitored Natural Attenuation at Superfund, RCRA Corrective Action, and Underground Storage Tank Sites	OSWER Directive 9200.4-17P	TBC	Guidelines for use of monitored natural attenuation for the remediation of contaminated soil and groundwater sites.	TBC if monitored natural attenuation is one of the selected corrective actions.
Occupational Health and Safety Act (OSHA)	29 USC Sections 651 through 678	Potentially Applicable	Regulates worker health and safety during implementation of remedial actions.	Applicable for site workers during all investigations and corrective actions at Site 6A, Site 10B, and the Southern Area.
State				
New York Air Pollution Control Regulations	6 NYCRR Parts 200 to 257	Potentially Applicable	Regulations for the control and prevention of air pollutants.	Remedial activities (air stripping, excavation, and vacuum extraction) may adversely impact air quality.
New York Waste Management Facilities Rules	6 NYCRR Part 360	Potentially Applicable	Provides standards for solid waste management facilities, including closure requirements.	Remedial activities may need to consider standards for solid waste management facilities.
New York Rules for Siting Industrial Hazardous Waste Facilities	6 NYCRR Part 361	Potentially Applicable	Provides evaluation criteria for siting new industrial hazardous waste facilities.	Remedial alternatives may need to consider criteria for industrial hazardous waste facilities.
New York Waste Transport Permit Regulations	6 NYCRR Part 364	Applicable	Regulates off-site transport of wastes.	Transport of contaminated soils/wastes and/or treatment residuals need to comply with these regulations.
New York General Hazardous Waste Management System	6 NYCRR Part 370	Potentially Applicable	Regulations that govern the management of hazardous waste.	Residuals from treatment could be considered as hazardous waste subject to these regulations.
New York Identification and Listing of Hazardous Wastes	6 NYCRR Part 371	Potentially Applicable	Regulations that govern the procedures for identifying a material as a hazardous waste.	Specific materials at the site may be classifiable as listed hazardous wastes or may test to be characteristic hazardous wastes.
New York Hazardous Waste Manifest System	6 NYCRR Part 372	Potentially Applicable	Regulations that govern the procedures for manifesting a material that is a hazardous waste.	Transport of contaminated soils/wastes and/or treatment residuals need to comply with these regulations.

TABLE 3-1

SUMMARY OF ARARs AND TBC CRITERIA
SITE 6A, SITE 10B, AND ON-SITE SOUTHERN AREA PLUME
NWIRP, CALVERTON, NEW YORK

Requirement	Citation	Status	Synopsis	Comment
Action-Specific ARARs and TBCs (Continued)				
State (Continued)				
New York Hazardous Waste Management Facilities	6 NYCRR Part 373	Potentially Applicable	Regulations that govern the treatment, storage, and disposal of hazardous waste.	Treatment and/or storage activities may take place on site. Site remediation activities must meet both administrative and the substantive technical permitting requirements.
New York Standards for the Management of Specific Hazardous Wastes and Specific Types of Hazardous Waste Management Facilities	6 NYCRR Part 374-1	Potentially Applicable	Regulations that govern the management of specific hazardous wastes.	Although unlikely, NWIRP site remedial alternatives may include product recovery.
New York Rules for Inactive Hazardous Waste Sites	6 NYCRR Part 375	Potentially Applicable	Requires State review and concurrence of the selected remediation scheme. The hierarchy of remedial technologies is as follows: (1) destruction, (2) separation/ treatment, (3) solidification/chemical fixation, and (4) control and isolation.	Site 6A and Site 10B/Southern Area work should comply with these regulations.
New York Land Disposal Restrictions	6 NYCRR Part 376	Potentially Applicable	Regulations that govern the treatment and disposal of certain hazardous waste.	Contaminated soils and/or treatment residuals may be considered hazardous waste subject to LDRs.
New York Rules on Hazardous Waste Program Fees	6 NYCRR Parts 483	Potentially Applicable	State hazardous waste program fees related to remedial actions.	Waste transporter program fees will be required for offsite disposal of wastes or treatment residuals.
New York Water Classifications and Quality Standards	6 NYCRR Parts 609 and 700 to 706	Potentially Applicable	Regulations for the control and prevention of water pollutants. NWIRP site groundwater is classified as GA.	Standards applicable for actions involving the selection of groundwater plume remediation goals as well as treatment goals for reinjection of treated effluent to the aquifer.
New York State Pollutant Discharge Elimination System (SPDES)	6 NYCRR Parts 750 to 758	Potentially Applicable	Regulations for the control of wastewater and storm water discharges in accordance with the CWA and controls point source discharges.	Permits (SPDES or NPDES) would be required for discharges to surface water.
New York Proposed SPDES	Proposed Subpart 750-1 and 750-2	TBC	Proposed regulation for the control of wastewater and storm water discharges in accordance with the CWA and controls point source discharges to groundwater as well as surface water. Once adopted, current Parts 750 to 758 will be repealed.	TBC as a proposed regulation, which may be in place prior to implementation of alternative. Treatment goals for discharge or reinjection of treated effluent.

NA = Not applicable.

TABLE 3-2

OVERALL ARAR- AND TBC-BASED STANDARDS FOR POTENTIAL GROUNDWATER CONTAMINANTS OF CONCERN (µg/L)
SITE 6A - FUEL CALIBRATION AREA
NWIRP CALVERTON, NEW YORK

Parameter	Maximum Detection	PQL	Federal MCLs/ MCLGs(1)	New York State Standards/Guidance					Preliminary Groundwater Remediation Goal(7)
				MCLs(2)	GW Quality Standards(3)	GW Effluent Standards(4)	TAGM 4046(5)	TOGS 1.1.1(6)	
Volatile Organic Compounds									
1,1,1-Trichloroethane	2000	0.5	200 (MCL)	5	5	NA	5	5	5
1,2-Dichlorobenzene	9	0.5	600 (MCL)	5	3	3	4.7	3	3
1,1-Dichloroethane	3400	0.5	NA	5	5	NA	5	5	5
1,1-Dichloroethene	30	0.5	7 (MCL)	5	5	NA	5	5	5
Benzene	43.9	0.5	5 (MCL)	5	1	1	0.7	1	1
Chloroethane	20	0.5	NA	5	5	NA	50	5	5
Ethylbenzene	46	0.5	700 (MCL)	5	5	NA	5	5	5
Toluene	140	0.5	1000 (MCL)	5	5	NA	5	5	5
Total Xylenes	510	0.5	10000 (MCL)	5	5	NA	5	5	5
Semivolatile Organic Compounds									
2-Methylnaphthalene	74	5	NA	50	NA	NA	50	NA	50
4-Methylphenol	84	5	NA	50	1 (tp)	2	50	1 (tp)	5 (1)(8)
Naphthalene	120	5	NA	50	NA	NA	10	10	10

GW - Groundwater.
MCL - Maximum Contaminant Level.
MCLG - Maximum Contaminant Level Goal.
NA - Not available.
PQL - Practical Quantitation Limit.
tp - total phenols.
1 - 2004 (Winter) Edition of the Drinking Water Standards and Health Advisories, Office of Water, EPA (EPA-822-R-04-005).
2 - New York Public Supply Regulations, 10 NYCRR Part 5, Subpart 5-1 Public Water Systems, Table 3 - Organic Chemicals Maximum Contaminant Level Determination and Table 9D - Organic Chemicals - Principal Organic Contaminants.
3 - 6 NYCRR Part 703 Surface Water and Groundwater Quality Standards and Groundwater Effluent Limitations, NYSDEC, Section 703.5, Table 1.
4 - 6 NYCRR Part 703, Surface Water and Groundwater Quality Standards and Groundwater Effluent Limitations, NYSDEC, Section 703.6, Table 3.
5 - Technical and Administrative Guidance Memorandum #4046, Determination of Soil Cleanup Objectives and Cleanup Levels, Tables 1 and 2.
6 - TOGS 1.1.1 Ambient water quality standards and guidance values, NYSDEC, Division of Water, June 1998, amended April 2000. Table 1.
7 - The most stringent promulgated standard (federal MCL, New York State MCL, and GW Quality Standard) was selected as the groundwater PRG. If the selected standard was less than the PQL, then the PQL was selected for the PRG.
8 - The selected PRG of 5 µg/L is the PQL. It is anticipated that a laboratory can reach a lower PQL. The goal for the laboratory analyzing Site 6A groundwater samples is to reach a PQL of 1 µg/L, which is equal to the New York GW Quality Standard.

TABLE 3-3

OVERALL ARAR- AND TBC-STANDARDS FOR POTENTIAL GROUNDWATER CONTAMINANTS OF CONCERN (µg/L)
SITE 10B - ENGINE TEST HOUSE AND ON-SITE SOUTHERN AREA
NWIRP CALVERTON, NEW YORK

Parameter	Maximum Detection	PQL	Federal MCLs/ MCLGs(1)	New York State Standards/Guidance					Preliminary Groundwater Remediation Goal(7)
				MCLs(2)	GW Quality Standards(3)	GW Effluent Standards(4)	TAGM 4046(5)	TOGS 1.1.1(6)	
Volatile Organic Compounds									
1,1,1-Trichloroethane	166	0.5	200 (MCL)	5	5	NA	5	5	5
1,1,2-Trichlorotrifluoroethane	152	0.5	NA	5	5	NA	5	5	5
1,1-Dichloroethane	49.2	0.5	NA	5	5	NA	5	5	5
1,1-Dichloroethene	188	0.5	7 (MCL)	5	5	NA	5	5	5
Benzene	1.95	0.5	5 (MCL)	5	1	1	0.7	1	1
Bromomethane	353	0.5	NA	5	5	NA	NA	5	5
Chlorobenzene	381	0.5	NA	5	5	NA	5	5	5
Chloroethane	138	0.5	NA	5	5	NA	50	5	5
Chloroform	15.3	0.5	80/70 THM	80 THM	7	7	7	7	7
Ethylbenzene	1084	0.5	700 (MCL)	5	5	NA	5	5	5
Methylene Chloride	7	0.5	5 (MCL)	5	5	5	5	5	5
Toluene	337	0.5	1000 (MCL)	5	5	NA	5	5	5
Total Xylenes	196	0.5	10000 (MCL)	5	5	NA	5	5	5
Vinyl Chloride	59.8	0.5	2 (MCL)	2	2	2	2	2	2

GW - Groundwater.
MCL - Maximum Contaminant Level.
MCLG - Maximum Contaminant Level Goal.
NA - Not available.
PQL - Practical Quantitation Limit.
THM - Total trihalomethane.
1 - 2004 (Winter) Edition of the Drinking Water Standards and Health Advisories, Office of Water, EPA (EPA-822-R-04-005).
2 - New York Public Supply Regulations, 10 NYCRR Part 5, Subpart 5-1 Public Water Systems, Table 3 - Organic Chemicals Maximum Contaminant Level Determination and Table 9D - Organic Chemicals - Principal Organic Contaminants.
3 - 6 NYCRR Part 703 Surface Water and Groundwater Quality Standards and Groundwater Effluent Limitations, NYSDEC, Section 703.5, Table 1.
4 - 6 NYCRR Part 703, Surface Water and Groundwater Quality Standards and Groundwater Effluent Limitations, NYSDEC, Section 703.6, Table 3.
5 - Technical and Administrative Guidance Memorandum #4046, Determination of Soil Cleanup Objectives and Cleanup Levels, NYDEC, Table 1.
6 - Technical and Operational Guidance Series 1.1.1 Ambient water quality standards and guidance values, NYSDEC, Division of Water, June 1998, amended
7 - The most stringent promulgated standard (Federal MCL, New York State MCL, and GW Quality Standard) was selected as the groundwater PRG. If the selected standard was less than the PQL, then the PQL was selected for the PRG.

TABLE 3-4

OVERALL ARAR- AND TBC-BASED STANDARDS FOR POTENTIAL SOIL CONTAMINANTS OF CONCERN (mg/kg)
SITE 6A - FUEL CALIBRATION AREA
NWIRP CALVERTON, NEW YORK

Parameter	Maximum Detection	PQL	New York State Guidance TAGM 4046[1]		New York State Guidance STARS Memo #1[4]		Preliminary Soil Remediation Goal[6]
			Protection of Groundwater[2]	USEPA Health Based[3]	TCLP Alternative Value[5]	Human Health Guidance[5]	
Volatile Organic Compounds							
Total Xylenes	17	0.01	1.2	200000 (S)	0.1	200000	0.12
Semi Volatile Organic Compounds							
Benzo(a)pyrene	0.11	0.33	11	0.061 (C)	0.00004	0.061	0.33 (0.061)[7]
Isophorone	5	0.33	4.4	1707 (C)	NA	NA	0.44
2-Methylnaphthalene	37	0.33	36.4	NA	NA	NA	3.64
Naphthalene	15	0.33	13	300 (S)	0.2	300	1.3
Nitrobenzene	2.4	0.33	0.2	40 (S)	NA	NA	0.33 (0.02)[7]
2-Nitrophenol	5.8	0.33	0.33	NA	NA	NA	0.33
Phenol	0.047	0.33	0.03	50000 (S)	NA	NA	0.33 (0.003)[7]
Polychlorinated Biphenyls							
Arochlor	330	0.33	NA	1 surface, 10 subsurface	NA	NA	1 surface, 10 subsurface

C - Carcinogens.
NA - Not available.
PQL - Practical Quantitation Limit.
S - Systemic Toxicants.

1 - Technical and Administrative Guidance Memorandum #4046, Determination of Soil Cleanup Objectives and Cleanup Levels, Tables 1 and 2. Total VOC concentration must be less than or equal to 10 ppm; Total SVOC concentration must be less than or equal to 500 ppm; Individual SVOC concentration can not exceed 50 ppm. In addition, although contaminant concentrations may be under the cleanup level; soil must not exhibit a discernible odor nuisance.
2 - Soil cleanup objectives to protect groundwater quality. Soil clean-up levels are developed for soil organic carbon content of 1 percent and should be adjusted for actual soil organic carbon content if it is known.
3 - EPA health-based cleanup objectives provided for Carcinogens (C) and Systemic (S) toxicants.
4 - Spill Technology and Remediation Series (STARS) Memo #1, Petroleum-Contaminated Soil Guidance Policy, August 1992.
5 - TCLP Alternative Values are for the protection of groundwater. For protection against objectionable nuisance, soil can not have a petroleum-type odor and no individual contaminant with concentration greater than 10 ppm. Standards are for gasoline-fuel-contaminated soil. For contaminants with high detection limits in comparison to TCLP Alternative Values, TCLP Extraction Method must be used to demonstrate groundwater quality protection for these contaminants.
6 - The most stringent TAGM 4046 clean-up objective was selected for the PRG. If the selected clean-up objective was less than the PQL, then the PQL was selected for the PRG. If the selected PRG was based on protection of groundwater, it has been adjusted for a site-specific TOC of 0.1 percent.
7 - The selected PRG is the PQL. The goal for the laboratory analyzing Site 6A soil samples is to reach the values presented in the parantheses which are the most strigent TAGM 4046 clean-up objective.

4.0 IDENTIFICATION AND SCREENING OF CORRECTIVE MEASURES TECHNOLOGIES

4.1 IDENTIFICATION AND PRELIMINARY SCREENING OF CORRECTIVE MEASURES TECHNOLOGIES

This section provides an initial identification and preliminary screening of Corrective Measures Technologies for soil (Section 4.1.1) and groundwater (Section 4.1.2). The preliminary screening of technologies is conducted to eliminate those technologies that clearly would not apply to the sites. Section 4.2 presents a more detailed identification and screening of technologies passing the preliminary screening.

The preliminary screening of technologies is based on their overall applicability (technical implementability) to the media (soil and groundwater), primary contaminants (chlorinated solvents, BTEX, SVOCs, PCBs, and petroleum hydrocarbons), and conditions present at the NWIRP facility (shallow, high-yield aquifer and sandy soils). The purpose of this screening effort is to investigate all available technologies and process options and to eliminate those obviously not applicable for the site, based on the established CAOs and a comparison of the concentrations of contaminants detected at each site to PRGs.

4.1.1 <u>Soil</u>

Initial screening of soil technologies applicable to both Sites 6A and 10B are presented in Table 4-1. Screening comments are provided in this table. The following factors were considered during the screening to determine the appropriate technologies for soil and to determine whether separate technologies were required to address soil independently from groundwater:

- Contaminants in soil were generally detected in a smear zone above or at the soil/groundwater interface. The source at Site 6A was a former floating product layer that resulted from spills at the ground surface. At Site 10B, contaminants are known to have been released to the subsurface via a leaking UST; however, significant amounts of free product have not been detected. Other contaminants (e.g. Freon) may have also been spilled at the surface at this site and migrated vertically.

- The contaminated soil was generally detected at depths between 5 and 7 feet bgs at Site 6A and between 4 and 10 feet bgs at Site 10B. These depths do not eliminate excavation as an alternative for soils. However, seasonal fluctuations in the groundwater table may result in contaminated soil being below the water table at various times throughout the year.

- Chlorinated solvents, BTEX, SVOCs, and petroleum hydrocarbons detected in soil at concentrations greater than PRGs might be effectively addressed by active groundwater remediation technologies or biodegrade naturally. However, the remaining free product trapped in the soil may minimize the effectiveness of active groundwater remediation technologies on the cleanup of contaminated soil. In addition, if contaminants in soil are allowed to degrade naturally, they would continue to be a source of contamination to groundwater.

- The PCBs in the soil would not be effectively addressed by active groundwater remediation technologies or biodegrade naturally.

The soil technologies retained from this preliminary screening are summarized in Table 4-2.

4.1.2 Groundwater

Initial screening of groundwater technologies is presented in Table 4-3. Screening comments are provided in this table. The following factors were considered during the screening to determine the appropriate technologies required to address the groundwater at Sites 6A and 10B/Southern Area:

- The water table aquifer is contaminated at the sites, and it consists of fine to medium sand and is approximately 57 feet thick. A clay layer is present at the bottom of the aquifer (approximately 60 feet bgs) that limits vertical migration of contamination.

- Different technologies may be applicable for the contaminants detected in the groundwater at Site 6A, Site 10B, and the On-Site Southern Area Plume.

- Maximum concentrations of COCs in Site 6A groundwater in 2005 were all less than 30 µg/L (1,1-dichloroethane) and most were detected in well FC-MW-02-S. Water quality data (methane, carbon dioxide, dissolved oxygen, ORP, etc.) collected in 2000 suggest that natural degradation processes are ongoing at the site.

- Maximum concentrations of COCs in Site 10B groundwater in 1997 were less than 1,100 µg/L for BTEX (ethylbenzene). No additional groundwater data have been collected at the site since 1997.

- Maximum concentrations of COCs in the On-Site Southern Area Plume in 1997 ranged from less than 400 µg/L (Freon 113) near Site 10B to less than 30 µg/L (1,1-dichloroethane) near the property boundary. No additional groundwater data have been collected in the area since 1997.

The groundwater technologies retained from this preliminary screening are summarized in Table 4-4.

4.2 SCREENING OF CORRECTIVE MEASURES TECHNOLOGIES

The technologies retained in the initial screening are briefly evaluated in this section. Technologies, which are retained for a site, will be evaluated in the detailed analysis sections for the respective sites.

The evaluation of technologies utilizes three criteria: effectiveness, implementability, and relative cost. The criteria are defined as follows:

- Effectiveness - This criterion focuses on the potential effectiveness of process options in protecting human health and the environment and in meeting the CAOs. This criterion considers potential impacts to human health and the environment during construction and implementation and how proven and reliable the process is with respect to the contaminants and conditions at the site.

- Implementability - Implementability is a measure of both the technical and administrative feasibility of implementing a technology. It provides a means of evaluating the ability of a technology to be adapted to site-specific conditions. Technical feasibility includes consideration of construction and operational issues, demonstrated performance, and adaptability to site conditions. Administrative feasibility considerations include the ability to obtain any necessary permits or easements or adherence to applicable nonenvironmental laws and concerns of other regulatory agencies. General availability of necessary equipment and resources is also evaluated.

- Cost - Cost evaluations allow a relative comparison between similar technologies. Cost plays a limited role in technology screening. The cost analysis is based on engineering judgement, and each technology is evaluated as to whether costs are high, low, or medium relative to the other options in the same technology type. If there is only one process option, costs are compared to other candidate technologies.

One representative process option is selected, if possible, for each technology type, to simplify the subsequent development and evaluation of alternatives without limiting flexibility during remedial design.

4.2.1 Corrective Measures Technologies for Soil

The general actions for soil are as follows:

- No action
- Limited Action
- Removal
- Disposal
- Ex-Situ Treatment
- In-Situ Treatment

4.2.1.1 No Action

No action consists of allowing the soil to remain in its current status at Sites 6A and 10B. Under this condition, the contamination in the soil will remain at original concentrations, and any reduction will be due to natural attenuating factors such as biodegradation.

Effectiveness: The no-action scenario would not achieve the remediation goals for Sites 6A and 10B. Soil with contaminant concentrations greater than PRGs would remain at the sites and would be uncontrolled and could affect personnel on site in the future. In addition, the soil contaminants would continue to impact groundwater indefinitely. The effectiveness of any natural reduction in contaminant concentrations would be unknown because no monitoring would be conducted.

Implementability: Because there would be no activity, there are no implementability considerations associated with the no-action scenario.

Cost: Because no action would be taken, there would be no costs associated with this option.

Conclusion: No action will be retained as a baseline for comparison to other alternatives.

4.2.1.2 Limited Action

Limited action for soil includes institutional controls (land use controls and deed notifications) and soil monitoring. Land use controls (Navy ownership) and deed notifications (public ownership) are institutional controls that are used to restrict future activities such as excavation and reuse of contaminated soil. Soil monitoring would be used to determine soil contaminant trends and the extent of contamination. Monitoring can also be used to monitor the progress of natural attenuation processes. Natural attenuation refers to inherent processes that affect the rate of migration and the concentrations of contaminants. The most important processes in soil are biodegradation, leaching from infiltration, sorption, and volatilization.

Effectiveness: Institutional controls would allow the contamination present in soil to remain at the sites. Land use controls or deed notifications could be used to ensure that contaminated soil is not excavated or reused in a way that would result in unacceptable risks to human health or the environment. However, these restrictions, over the long term, may not be reliable and are difficult to enforce especially when the site is no longer under government control. Soil monitoring would not provide any additional protection of the environment because the contaminated soil would remain at the sites; however, soil monitoring could be used to evaluate whether contaminant concentrations are decreasing by natural processes.

Implementability: Institutional controls are readily implementable for contaminated soil because only administrative action and limited remedial activities would be required. Land use controls and deed notifications could be implemented by the Navy. Limited equipment and personnel would be required for soil monitoring. It is unlikely that any local or State permits would be required for soil monitoring. Monitoring would be required for an extended period of time (possibly greater than 30 years) until PRGs are reached.

Cost: Costs of implementing institutional controls and monitoring for soil are low.

Conclusion: Institutional controls (land use controls and deed notifications) and soil monitoring will be retained to be used alone or in combination with other process options at Sites 6A and 10B. Institutional controls would not prevent contaminants in soil from migrating to groundwater at Sites 6A and 10B; however, they would restrict direct contact with contaminated soil and minimize potential risks associated with contact with the soil. Most of the site contaminants (petroleum) are relatively biodegradable, and monitoring would determine contaminant trends in the soil. PCBs would be expected to remain at the site indefinitely.

4.2.1.3 Removal

Removal can involve excavation of all contaminated soil or selective removal of source area "hot spots" from a site. Hydraulic excavators, track loaders, backhoes, and grade-alls are generally used to perform excavation. The type of equipment selected must take into consideration several factors including type of material, load-supporting ability of the soil, rate of excavation required, and depth of excavation. There is an estimated 3,380 cubic yards and 770 cubic yards of contaminated soil at Sites 6A and 10B, respectively, that would need to be excavated. It was estimated that 410 cubic yards of soil at Site 6A are contaminated with PCBs (120 cy of PCB-contaminated soil is included with the 3,090 cy of petroleum-contaminated soil, and 290 cy of PCB-contaminated soil is found in the 7,710 cy of overburden soil above the petroleum contaminated soil). Therefore, to access the contaminated soil, approximately 7,420 cubic yards of clean soil and 320 cubic yards of concrete would need to be removed at Site 6A and 1,860 cubic yards of clean soil and 240 cubic yards of concrete would need to be removed at Site 10B. Excavated contaminated soil can be placed directly onto trucks for off-site treatment/disposal, or if on-site treatment is performed, transferred to a staging area prior to treatment. The clean soil would be separated, staged, and reused as fill for the excavation. The concrete could possibly be used as fill or disposed off site.

Effectiveness: Excavation is a well-proven and highly effective method for removing material impacted with any type of contamination from a site. Excavation options must be combined with other disposal or treatment options. Confirmatory sampling (bottom and sidewalls) would be conducted to verify the effectiveness of the excavation. If the excavation terminates at the water table, no confirmatory sampling would be required from the bottom of the excavation. If any contaminated soil is below the water table at the time of excavation, additional effort to excavate and dewater the soils would be required.

Implementability: The required services and equipment for excavation to depths of less than 10 feet (i.e., maximum depth of contaminated soil at Sites 6A and 10B) and for the required volumes (approximately 4,150 cubic yards of contaminated soil and 9,280 cubic yards of clean soil) are readily available. Reinforced concrete (560 cubic yards) would need to be removed at both sites prior to excavation. A steel building with an area of approximately 3,800 square feet may also need to be removed prior to excavation at Site 10B. Various engineering controls and the use of personal protective equipment would be required during excavation. If the water table is elevated at the time of excavation, significant dewatering may be required to allow for excavation of the contaminated soil. Any water collected during dewatering activities would need to be treated as necessary and disposed of properly. Saturated soil or soil containing free product would need to be pre-treated (i.e., staged on a dewatering pad to remove free liquids) prior to transportation/disposal or treatment.

Cost: Excavation costs are directly proportional to the extent of excavation required. If dewatering is a concern at the sites or if extensive engineering controls are required, excavation costs would increase. In general, excavation costs are moderate when compared to other options.

Conclusion: Excavation of impacted soil would be highly effective and implementable when combined with subsequent disposal or treatment. Therefore, this technology will be retained for Sites 6A and 10B.

4.2.1.4 Disposal

Excavated contaminated soil can be disposed using various methods including off-site disposal at a permitted disposal facility, recycled in asphalt, or beneficially reused on site as fill material after treatment. The type of disposal appropriate for the excavated soil depends on the type and magnitude of contaminants in the soil. Other material at Sites 6A and 10B including concrete, steel building, liquids, and free product may also require disposal.

Off-site disposal can generally be used for any type of material and involves transport of excavated soil or other waste material (concrete, steel building, liquids, or free product) to an appropriate off-site disposal facility. On-site pre-treatment of saturated soil or soil containing free product (i.e., dewatering pad to remove free liquids) would be required prior to off-site transportation of soil for disposal or treatment. A permitted TSD facility would be required for any hazardous waste as defined by RCRA or TSCA. In addition, LDRs require that some hazardous wastes be treated to render them nonhazardous prior to disposal. A permitted solid waste disposal facility would be used for all nonhazardous waste as defined by RCRA.

Soil contaminated with petroleum hydrocarbons at concentrations less than hazardous waste limits can be recycled in asphalt. Asphalt batching plants must be available and willing to take the soil. Soils contaminated with chlorinated solvents and PCBs cannot be recycled in asphalt.

Excavated soil can be treated on site and then beneficially reused as fill material. This option is only viable if treatment options can reach the required soil PRGs. This option eliminates the need to import new clean soil for use as fill.

Effectiveness: Off-site disposal is effective because contaminated media are taken off site, and minimal residual risk would remain. Landfills can be used for disposal of soil and other solid waste, and they are effective at isolating wastes from the environment. Treatment facilities can be used for disposal of liquid wastes. The waste-specific requirements vary from state to state and by individual landfill. The selection is based on waste-specific effectiveness, permitting, and cost considerations.

Recycling of petroleum-contaminated soil would be effective. However, the heterogeneous nature of the contamination in the soil at Sites 6A and 10B may make this option ineffective. Testing would need to be conducted to confirm its effectiveness. This option can be considered in place of disposal for other material (concrete and liquids).

Beneficial reuse would be an effective use of the contaminated soil after treatment. It would reduce or eliminate the need for off-site disposal and importing clean fill.

Implementability: Off-site disposal of contaminated soil and other material is implementable. Hazardous and nonhazardous disposal facilities are available. On-site pre-treatment of saturated soil or soil containing free product (i.e., dewatering pad to remove free liquids) would be required prior to off-site transportation for disposal or treatment. Testing would be required to characterize any waste prior to disposal. The results would be used to determine if pretreatment was necessary and to select an appropriate disposal facility. Recycling of soil contaminated with only petroleum hydrocarbons at concentrations less than hazardous waste limits can be implemented, but asphalt batching plants must be available and willing to take the soil. Beneficial reuse of treated soil can be easily implemented.

Cost: The cost of off-site disposal is highly variable, ranging from low to high for nonhazardous and hazardous wastes, respectively. The only costs associated with recycling or beneficial reuse would be transportation.

Conclusion: Off-site disposal and beneficial reuse of contaminated soil after treatment will be retained for consideration for contaminated soil at Sites 6A and 10B. Recycling will be retained as feasible.

4.2.1.5 Ex-Situ Treatment

Once excavated, contaminated soil can be treated and reused on site or sent off-site for treatment and disposal. Low-/high-temperature thermal stripping was the only ex-situ treatment option retained for further evaluation from the initial screening. The technology uses low to high temperatures to volatilize organics. The off-gas generated during stripping may require treatment to capture contaminants. The temperatures and residence times used to treat the contaminated soil are designed for the selected COCs. Low temperatures are effective on petroleum hydrocarbons and solvents, and high temperatures are effective on SVOCs and PCBs. COC destruction efficiencies of the units are typically greater than 95 percent. Treated soil generally retains its physical properties and ability to support biological activity if backfilled. Two common types of thermal units are the rotary dryer and thermal screw. Soil throughput rates are typically 15 to 20 tons per hour for sandy soils. Most of the units are transportable and can be mobilized to a site for on-site treatment.

Effectiveness: Thermal stripping can be effective for treating the contaminated soil at Sites 6A and 10B. The efficiencies of the system should allow soil to be reused on site to be treated to PRGs and soil to be disposed off site to be treated to required concentrations (e.g., LDRs). Additional soil characterization and treatability studies would be required to design the appropriate treatment system (temperatures, residence times, and off-gas treatment).

Implementability: The required equipment and vendors are available to treat contaminated soil on site and TSD facilities are also available to treat the contaminated soil off site. Many vendors offer low-temperature thermal desorption units mounted on a single trailer. Fewer venders offer high-temperature desorption units and these units are typically larger and mounted on multiple trailers. Dewatering of the contaminated soil may be necessary to achieve acceptable soil moisture content levels prior to treatment.

Air emission controls may be required to protect human health and the environment. State and local permits may be required and may be difficult to obtain, especially for PCB-contaminated soils.

Cost: Costs for ex-situ thermal treatment of excavated soil are moderate to high. Mobilization costs can be high for mobile units, especially high-temperature units with air emission controls.

Conclusion: On-site and off-site ex-situ thermal treatment of excavated soil will be retained for Sites 6A and 10B. On-site thermal treatment will be considered so that the contaminated soil can be reused as fill material. Off-site treatment will be considered for any soil designated as hazardous or TSCA waste that requires pretreatment prior to off-site disposal.

4.2.1.6 In-Situ Treatment

In-situ treatment involves the remediation of contaminated soil with no or limited excavation and injections. Soil vapor extraction (SVE) and chemical oxidation were the two treatment technologies that were retained from the initial screening.

<u>SVE</u>

SVE involves using a vacuum to induce controlled flow of soil vapor from the vadose zone to remove contaminants (VOCs and some SVOCs) from the soil. It can also be used in conjunction with groundwater technologies such as air sparging to control soil vapor emissions. Horizontal or vertical screened extraction wells are installed into the vadose zone to serve as SVE collection points. Vertical extraction vents are typically used at depths of 1.5 meters (5 feet) or greater and have been successfully applied as deep as 91 meters (300 feet). Horizontal extraction vents (installed in trenches or horizontal borings) can be used as warranted by contaminant zone geometry, drill rig access, or other site-specific factors. Geomembrane covers are often placed over the soil surface to prevent short circuiting and to increase the radius of influence of the extraction vents. The extraction vacuum often affects the groundwater table making groundwater depression pumps necessary to reduce groundwater upwelling. Application of SVE is limited by the heterogeneity and permeability of the soil matrix as well as the volatility characteristics of the target COCs. Treatability studies are typically required to identify the effectiveness of SVE in a specific location. A treatment building is used to house the SVE blower system, which includes particulates and condensate removal components. Off-gas treatment is usually required to remove contaminants from extracted soil vapor prior to release to the atmosphere. Similarly, on-site treatment or off-site disposal is typically required for contaminated condensate and media used for treatment of the off-gas (activated carbon). A supplemental benefit of SVE is that the increased oxygen concentrations in the unsaturated zone resulting from entrainment of atmospheric air can promote the biodegradation of certain organic compounds (BTEX and petroleum hydrocarbons).

Effectiveness: SVE is an effective, well-documented technology for recovering elevated concentrations of VOCs from the unsaturated zone. Removal of up to 90 percent of VOCs is possible. SVE would be effective for the approximately 230 pounds of chlorinated solvents and BTEX in the soil at Sites 6A and 10B, and moderately effective for approximately 43,450 pounds of SVOCs and petroleum hydrocarbons (i.e., 90-percent removal). It would not be effective for the 130 pounds of PCBs at Site 6A. The relatively homogeneous sandy soil at the sites would be amenable to SVE. The shallow water table (7 feet bgs) and seasonal fluctuations in the water table (up to several feet) may limit the amount of unsaturated contaminated soil and the effectiveness of SVE. The SVE system could only be operated when the water table elevation was below the extraction wells.

Implementability: Vendors and equipment are available for SVE. Due to the shallow water table and seasonal fluctuations in the water table horizontal versus vertical extraction wells may be more implementable at these sites. The SVE system could not be operated when the water table was above the extraction wells. Air discharge permits would be required for the system, which should be obtainable as long as vapor phase treatment is used.

Cost: Costs for implementing SVE are directly related to the duration of treatment and the amount of off-gas treatment, but they are typically moderate.

Conclusion: SVE will be retained to be used alone or in combination with other process options at Sites 6A and 10B. SVE should be effective for chlorinated solvents, BTEX, SVOCs and petroleum contaminants in the soil at Sites 6A and 10B, but is not effective for PCBs.

<u>Chemical Oxidation</u>

In situ chemical oxidation (ISCO) is an innovative, full-scale technology that has been used for the remediation of contaminant source zones in soil and groundwater. The oxidant chemicals react with the contaminants, producing innocuous substances such as carbon dioxide, water, and inorganic chloride. Contaminants that can be treated include BTEX, PAHs, chlorinated solvents, and many other organic contaminants. Typical oxidants that are used in this technology are Fenton's Reagent, hydrogen peroxide, ozone, potassium permanganate, sodium permanganate, sodium persulfate, and sodium percarbonate. Some of the oxidants only work well on certain types of contaminants and a bench-scale treatability study would be required to determine the best type of oxidant for the site-specific contaminants and conditions.

The effectiveness of the technology is highly dependent on the following:

- The subsurface hydrogeology of the site
- The delivery/injection system methodology
- The nature and extent of contamination
- Other site-specific conditions such as presence of total organic carbon which can compete with target COCs for available oxidants.

ISCO technology can be applied alone or in conjunction with other remedial technologies; however, application of ISCO can disrupt other remedies. For example, application of ISCO on a site that is benefiting from natural reductive dehalogenation may temporarily upset the geochemistry that facilitates the process. The primary advantage of ISCO is the potential to reduce contaminant concentrations to remedial goals within a very short timeframe. Another benefit would be that implementation of the technology would not generate large volumes of waste material that would need to be disposed of or treated.

Effectiveness: ISCO technology would be effective at significantly reducing the free product and contaminants sorbed to the soil at Sites 6A and 10B. Hydrogen peroxide and sodium percarbonate may be effective on a majority of the contaminants at the sites. Sodium persulfate would be effective on the BTEX, PAHs, and other petroleum contamination at the site. Permanganates are generally effective on chlorinated solvents, but not on chlorinated ethanes which are present at Sites 6A and 10B. Some oxidants include impurities such as heavy metals that result in new contamination being released to the environment which reduces the effectiveness of the treatment. ISCO technology is not effective on PCBs and some information suggests that treatment of PCBs with ISCO may result in the creation of contaminants that are more toxic than PCBs. It was estimated that 410 cubic yards of soil at Site 6A are contaminated with PCBs.

Implementability: Vendors and equipment are available to supply the oxidants and apply ISCO technology. Bench-scale and pilot studies would need to be conducted prior to full-scale implementation of the technology. The oxidants pose potential health and safety hazards (direct contact and vigorous uncontrolled reactions) that would need to be addressed as part of the design and implementation of the technology. Another implementation issue that would need to be addressed would be the potential for the release and migration of potentially harmful chlorinated vapors due to oxidation of chlorinated hydrocarbons. Utility surveys would need to be conducted to account for the effect of underground piping, utilities, or trenches on preferential pathways and/or pockets for organic decomposition, explosive liquids and vapors, and oxygen. Permits would likely be required because the oxidants and their impurities may impact the groundwater below the treatment zone. It is likely that multiple treatments would be required to fully treat the contamination that is present in the soil.

Cost: The costs of implementing ISCO technology are generally moderate to high depending on site conditions and the amount of contaminated media that requires treatment. The oxidants typically cost between $2.00 per pound to $6.00 per pound and the oxidant to contaminant application ratio on a weight basis ranges from approximately 1 to 21 depending on the oxidant and contaminant.

Conclusion: ISCO can significantly reduce the amount of contaminants in the soil at Sites 6A and 10B in a relatively short amount of time; however, there are significant implementation issues that need to be considered. ISCO will be retained for consideration for the contaminated soil at Sites 6A and 10B with the exception of the PCB-contaminated soil at Site 6A (approximately 410 cubic yards). The technology can be used alone or in combination with other process options at Sites 6A and 10B.

4.2.2 Corrective Measures Technologies for Groundwater

The general actions for groundwater are as follows:

- No action
- Limited Action
- Removal
- Disposal
- Ex-Situ treatment
- In-Situ treatment

4.2.2.1 No Action

No action consists of allowing the groundwater to remain in its current status. Under this condition, the contamination in the groundwater will remain at original concentrations, and any reduction will be due to natural attenuating factors such as dilution, dispersion, biodegradation, adsorption, infiltration, etc.

Effectiveness: The no-action scenario would not achieve remediation goals for the groundwater at Site 6A, Site 10B, or the On-Site Southern Area Plume. Under this scenario, groundwater with contaminant concentrations greater than the PRGs would remain for a long time, especially if the contaminant sources in the soil are not addressed. The effectiveness of any natural reduction in contaminant concentrations would be unknown because no monitoring would be conducted. Without restrictions, groundwater could be used as a potable water supply.

Implementability: Because there would be no activity, there would be no implementability considerations associated with the no-action scenario.

Cost: Because no action would be taken, there would be no costs associated with this option.

Conclusion: No action is retained to provide a baseline for comparison with other alternatives.

4.2.2.2 Limited Action

Limited action for groundwater includes institutional controls (land use controls, deed notifications, and providing an alternative water supply), groundwater monitoring, and natural attenuation. Land use controls (Navy ownership) and deed notifications (public ownership) are institutional controls used to restrict future activities such as placement of new wells or construction. An alternative water supply could be provided if the contaminated groundwater was used as a drinking water source (i.e., provide connection to a public water supply). Groundwater monitoring would be used to determine groundwater contaminant trends and the extent of contaminant migration. Monitoring can also be used to monitor the progress of groundwater remediation and natural attenuation process. Natural attenuation refers to inherent processes that affect the rate of migration and the concentrations of contaminants. The most important processes are biodegradation, advection, hydrodynamic dispersion, dilution from recharge, sorption, and volatilization.

Effectiveness: Institutional controls would allow any contamination present in groundwater to remain at the sites. Land use controls or deed notifications could be used to ensure that no drinking water wells would be installed to extract contaminated groundwater, thereby reducing the potential risk to human health associated with ingestion/inhalation of contaminated groundwater. However, these restrictions, over the long term, may not be reliable and are difficult to enforce especially when the site is no longer under government control. An alternative water supply would effectively eliminate future human exposure to contaminated groundwater via ingestion/inhalation. Groundwater monitoring would not provide any additional protection of the environment, because contaminated groundwater would continue to spread into uncontaminated or lesser-contaminated areas. Groundwater monitoring would be used to evaluate contaminant trends and plume expansion. Monitoring would also be helpful in measuring and evaluating the effectiveness of groundwater remediation and natural attenuation processes. Natural attenuation is effective if the rate of biodegradation, aided by sorption and dilution, is rapid enough to prevent significant migration by advection and dispersion. The effectiveness of natural attenuation would be improved if the contaminant sources in the soil are addressed. Monitoring is a key component in confirming the effectiveness of any groundwater alternative.

Implementability: Institutional controls are readily implementable for contaminated groundwater because only administrative action and limited remedial activities would be required. Land use controls and deed notifications could be implemented by the Navy. Alternative water supplies could be identified and provided. Limited equipment and personnel would be required for groundwater monitoring. Local and State permits may be required for monitoring well installation. Monitoring of natural attenuation would be readily implementable; however, monitoring would be required for an extended period of time (possibly greater than 30 years) until PRGs are reached.

Cost: Costs of implementing institutional controls are low, and costs of implementing monitoring and natural attenuation are low to moderate.

Conclusion: Institutional controls (land use controls and deed notifications), groundwater monitoring, and natural attenuation will be retained to be used alone or in combination with other process options for the groundwater at Site 6A, Site 10B, and the On-Site Southern Area Plume. There are no current on-site users of groundwater as a drinking water source; therefore, an alternative water supply does not need to be provided, and this option will not be retained for further evaluation. Institutional controls would not prevent continued contaminant migration in the groundwater; however, most of the site contaminants are relatively biodegradable (BTEX), and monitoring would determine whether contaminants are migrating off site. Chlorinated solvents may continue to migrate. The overall effectiveness of natural attenuation will be improved if groundwater contaminant sources in soil are addressed.

4.2.2.3 Removal

Contaminated groundwater can be extracted using extraction wells or collection trenches. Due to the depth of contaminated groundwater (approximate maximum depth at all sites of 57 feet bgs), extraction wells would better suited for Site 6A, Site 10B, and the On-Site Southern Area Plume. For the extraction option, a series of pumping wells would be completed in the overburden aquifer and used to capture contaminated groundwater for treatment. The wells used in the capture system would be designed and located to provide optimum efficiency in capturing contaminated groundwater while minimizing the collection of uncontaminated groundwater. The extraction system can be designed for hydraulic control to contain the contaminated groundwater plume from migrating off site or to remediate the contaminated groundwater plume.

The extraction option involves the active manipulation and management of groundwater to contain or remove a plume. The selection of the appropriate well system depends upon the depth of contamination and the hydrologic and geologic characteristics of the aquifer. Well systems are very versatile and can be used to contain, remove, divert, or prevent development of plumes under a variety of site conditions.

Effectiveness: The effectiveness of an extraction well system depends largely on the type and extent of contamination and the geology and hydrogeology. For these sites, extraction wells should effectively control the migration of contaminants and remove the contaminated groundwater for subsequent treatment and/or disposal. More mobile chemicals will be more readily removed than less mobile chemicals. The use of wells to extract contaminated groundwater should eventually attain the PRGs. The time required to reach PRGs would decrease if groundwater contaminant sources in the soil are addressed. The technology is reliable and minimal effects on human health and the environment are expected.

Implementability: Groundwater extraction through a pumping well system can be readily implemented. The technology uses readily available equipment and techniques and has proven to be effective in similar situations. Implementation of this technology would require long-term operation and maintenance. Maintenance may require periodic replacement of mechanical components and well cleaning/flushing to remove iron scaling and fine-grained material that may clog the wells. Local and State permits may be required for installation of extraction wells. Extracted groundwater would require treatment prior to disposal.

Cost: Costs for installing a groundwater extraction system are low, but costs for operation and maintenance of the system can be moderate to high depending on the size of the system and the duration of pumping.

Conclusion: Groundwater extraction is retained for consideration for the groundwater at Site 6A, Site 10B, and the On-Site Southern Area Plume. Groundwater extraction would be completed at Site 6A and Site 10B to remediate the contaminated plumes. Groundwater extraction of the On-Site Southern Area Plume would be completed to gain hydraulic control and contain the contaminated groundwater plume from migrating off site and to remediate the contaminated groundwater plume.

4.2.2.4 Disposal

The reinjection option was retained for disposal during the initial technology screening. Reinjection consists of disposing of treated groundwater in the original aquifer from which it was removed. Based on the relatively shallow groundwater table at the sites, infiltration galleries would be the best option. Reinjection may be used to increase contaminant removal by creating artificial hydraulic gradients that direct groundwater toward extraction wells. Reinjection can be coupled with extraction wells to create a closed system in which pumping and injection rates balance one another.

Effectiveness: Reinjection via infiltration galleries is an effective means of disposing of the volumes of water generated by a groundwater pumping/treatment system. Infiltration galleries offer the advantage of decreasing groundwater remediation time by increasing groundwater flow through the aquifer. The vertical infiltration of treated groundwater through the vadose zone will create elevated groundwater conditions (i.e., groundwater mounding) in the vicinity of the infiltration gallery, requiring detailed flow modeling to ensure that the design of the infiltration gallery can accommodate these changes to the aquifer. The effectiveness of reinjection depends on hydraulic conductivity, aquifer thickness, and hydraulic gradient/aquifer recharge rate. This method of disposal would require treatment of the water to meet PRGs. The use of reinjection would avoid transporting and disposing of the groundwater off site.

Implementability: Installation of an infiltration gallery system for underground injection is implementable using established procedures. Vendors and equipment for installation are commercially available. Reinjected water could potentially force contaminated groundwater into less-contaminated areas. The groundwater extraction system should be designed so that it adequately captures the contaminated groundwater. Periodic groundwater monitoring would be needed to assess the impacts of reinjection. The extracted groundwater would require treatment to PRGs prior to reinjection. Reinjection of water into the aquifer may require State and local permits. The permits would set limitations on contaminant concentrations and possible flow rates of treated water. The permits should be obtainable provided that PRGs are achieved prior to reinjection.

Cost: Costs for construction and operation and maintenance of a reinjection system (infiltration gallery) would be low to moderate.

Conclusion: Reinjection (infiltration gallery) is retained for consideration for the groundwater at Site 6A, Site 10B, and the On-Site Southern Area Plume. This process will be used in combination with other technologies such as extraction and ex-situ treatment.

4.2.2.5 Ex-Situ Treatment

Ex-situ treatment consists of the use of technologies for treatment of groundwater after extraction. Air stripping was determined to be the best primary process option for the COCs in groundwater at the sites after the initial screening of technologies. Adsorption using activated carbon would also be a treatment option for the groundwater COCs, especially petroleum hydrocarbons and SVOCs. A treatability study would be required to determine the best use of the two technologies. Other processes such as dewatering, equalization, filtration, flotation, clarification, neutralization, flocculation, and precipitation would be secondary process options that could be used as necessary, depending on site conditions, with air stripping or adsorption to enhance the effectiveness of the treatment system. The processes applicable for treatment of site-specific groundwater contamination will be assembled into a treatment system in the detailed analysis. These technologies may also be appropriate for treatment of water removed during dewatering activities.

<u>Air Stripping</u>

Air stripping is a mass transfer process in which volatile contaminants (compounds with Henry's Law constants greater than $3.0x10^{-3}$ atm-m^3/mol) in water or soil are transferred to gas. There are five basic equipment configurations used to airstrip liquids: packed columns, cross-flow towers, coke tray aerators, diffused air basins, and mixing jets.

Air stripping is frequently accomplished in a packed tower equipped with an air blower. The packed tower works on the principle of countercurrent flow. The water stream flows down through the packing while the air flows upward and is exhausted through the top of the tower. Volatile, soluble components have an affinity for the gas phase and tend to leave the aqueous stream for the gas phase. In the cross-flow tower, water flows down through the packing as in the countercurrent packed column; however, the air is pulled across the water flow path by a fan. The coke tray aerator is a simple, low-maintenance process requiring no blower. The water being treated is allowed to trickle through several layers of trays. This produces a large surface area for gas transfer. Diffused aeration stripping and induced draft stripping use aeration basins similar to wastewater treatment aeration basins. Water flows through the basin from top to bottom or from one side to another with the air dispersed through diffusers at the bottom of the basin. The air-to-water ratio is significantly lower than in either the packed column or the cross-flow tower. Mixing jet systems involve high-intensity mixing of pressurized air and water. The air-to-water flow ratio, temperature of the water, and height of packing may be adjusted to achieve adequate removal of VOCs to meet discharge standards. Typically, pretreatment for removal of suspended solids, organic free product, and scaling constituents would be required for air stripping.

Effectivenes: Air stripping is a well proven and reliable technology that would be effective for removing VOCs from groundwater. It would be less effective for the SVOCs detected in groundwater. Removal efficiencies greater than 99 percent can theoretically be achieved for the VOCs. A treatability study would be required to confirm the effectiveness of air stripping. Because air stripping only removes contaminants from water and concentrates them in the offgas, the offgas may have to be treated by other means such as granular activated carbon adsorption, catalytic oxidation, or thermal destruction. The need and type of off-gas treatment depends on the specific contaminants and their concentrations. Each of the noted off-gas treatment technologies should be effective for the contaminants in groundwater at Sites 6A and 10B/Southern Area.

Implementability: Air stripping would be readily implementable at the sites. Vendors that provide air-stripping technology are readily available. In order to meet State Ambient Air Quality Standards, control of off-gas emissions and an air permit may be required. Construction permits may also be required. Both permits should be obtainable, but the air permit may be difficult to obtain.

A maintenance problem associated with air stripping is the channeling of flow resulting from clogging in packing material. Common causes of clogging include high concentrations of oils, suspended solids, iron, and slightly soluble salts such as calcium carbonate. Pretreatment of contaminated groundwater would be required prior to air stripping to remove such materials.

Cost: Costs are low to moderate for air stripping and will depend on influent contaminant concentrations, the degree of removal required, and the type of off-gas treatment required.

Conclusion: Air stripping is retained for treatment of groundwater extracted from Site 6A, Site 10B, and the On-Site Southern Area Plume.

<u>Activated Carbon Adsorption</u>

A large variety of organic contaminants and some inorganic ionic species commonly found in groundwater are amenable to removal by adsorption onto activated carbon. Contaminants adsorb to the internal pore surfaces of activated carbon particles as the contaminated water passes through a column of the activated carbon. When the available surface area of the activated carbon particles is occupied, the column must be replaced by fresh activated carbon. The exhausted carbon must then be either regenerated or disposed according to federal or State regulations. Removal efficiency exceeding 99 percent is possible depending on the type of organic solute and system operating parameters such as retention time and carbon replacement frequency.

Among organic contaminants, long-chain, low solubility, less polar compounds have a greater affinity for adsorption than others. The adsorption of organic acids is favored by low pH conditions in the water, whereas that of organic bases is favored by high pH conditions.

The presence of high levels of suspended solids can clog the flow of water through the column. The presence of organic free product can hinder the adsorption of target dissolved contaminants by coating the surfaces and exhausting the column quickly. Because of the nonselective nature of this technology, the presence of naturally occurring organic substances can significantly increase the consumption rate of activated carbon.

Typical activated carbon adsorption treatment systems include gravity flow or pressure flow columns in series and/or parallel configuration some with backwashing capability. Granular activated carbon (GAC) is generally used in these systems. Common flow rates range from 0.5 to 5.0 gallons per minute per square feet (gpm/ft^2). Factors such as pH and temperature of the influent, empty bed contact time (EBCT), surface area/volume ratio of the activated carbon, and solubilities of the organic compounds will affect the carbon adsorption process.

Effectiveness: Carbon adsorption is a well-proven, reliable technology that would be effective in removing most organic contamination (petroleum hydrocarbons and SVOCs). Carbon adsorption would not be as effective for some chlorinated solvents (e.g., dichloroethane). Generally, the most effective application of carbon adsorption would be for dilute concentrations of organics that result in relatively low carbon consumption. Removal efficiencies exceeding 99 percent, with nondetected organics in effluents, are commonly achievable. Spent carbon containing the removed organic contaminants would have to be regenerated or disposed in a hazardous waste landfill.

Implementability: Carbon adsorption would be readily implementable. There are a sufficient number of vendors that provide carbon adsorption units. Construction permits may also be required. These permits should be obtainable.

Pretreatment may be required if the influent has a suspended solids concentration greater than 15 mg/L, oil and grease concentrations greater than 10 mg/L, or calcium or magnesium concentrations greater than 500 mg/L to prevent clogging and high pressure drops.

Implementation factors include planning for disposal or regeneration of the spent carbon. Thermal, steam, and solvent treatments are the most common types of regeneration technologies, which are typically conducted off site.

Cost: Costs are low to moderate, depending on the carbon usage rate, which is a function of influent contaminant concentrations.

Conclusion: Carbon adsorption is a viable technology for treating most site organics and in particular petroleum hydrocarbons and SVOCs. It is retained for further consideration in combination with air stripping for treatment of groundwater extracted from Site 6A, Site 10B, and the On-Site Southern Area Plume.

4.2.2.6 In-Situ Treatment

In-situ treatment involves the remediation of groundwater within an aquifer with no or limited extraction and injection. The main technologies that passed the initial screening were air sparging and biological treatment.

<u>Air Sparging</u>

In-situ air sparging consists of injection of contaminant-free air into the saturated zone within the contaminated plume. The injected air bubbles disperse within the saturated zone and contact the contaminants. In this process, the VOCs adsorbed on the soil particles and dissolved in the water are volatilized, like an in-situ air stripping process. The VOCs are then carried into the vadose zone by the air phase, within the radius of influence of an operating vapor extraction system.

Air sparging is often used in combination with SVE and bioventing. With this technology, the removal of contaminants is achieved by air stripping/biodegradation of VOCs and biodegradation of SVOCs. Most petroleum hydrocarbon contaminants are amenable to removal from the saturated zone using this technology. Air stripping and biodegradation of contaminants can occur simultaneously in groundwater as well as in saturated zone soils.

Effectiveness. Air sparging should be effective for the volatile contaminants (chlorinated solvents, BTEX, and other VOCs) detected in groundwater at Site 6A, Site 10B, and the On-Site Southern Area Plume. Removal of volatile contaminants from the aquifer would be by volatilization, whereas removal of any remaining organics would be by volatilization and/or biodegradation. Free product in a smear zone just above the water table may reduce vapor migration and the effectiveness of air sparging. Air sparging is a proven technology; however, treatability work would be required. In combination with SVE, it should be very reliable and there should not be any significant risks to human health and the environment. Without SVE, contaminant vapors may migrate to the ground surface and discharge to the atmosphere at unacceptable levels or migrate laterally to adjacent buildings, which may result in risks to human health and the environment. Air sparging may cause groundwater mounding in the treatment area and result in gradients that cause contamination to migrate in new directions. Groundwater monitoring would be required to track contaminant migration.

Implementability: Air sparging would be implementable at Site 6A and Site 10B. Air sparging would not be implementable for the On-Site Southern Area Plume due to its size. Permits should not be required for the air sparging component; however, air discharge permits would be required for the associated SVE system. Vendors are available to perform this work. The shallow depth of groundwater at the sites and seasonal fluctuations of the water table may reduce the implementability of SVE.

Cost: The costs associated with air sparging and SVE are low to moderate depending on the size of the system and the duration that the system is operational.

Conclusion: Air sparging will be retained for further consideration for the groundwater at Site 6A and Site 10B. It will not be considered for the On-Site Southern Area Plume. The need for SVE will be evaluated.

<u>In-Situ Biological Treatment</u>

In-situ bioremediation is the process by which microorganisms biologically degrade organic compounds to less harmful degradation products such as carbon dioxide, methane, and water. This process is conducted in the subsurface by providing indigenous microorganisms optimum conditions for growth, such as controlled pH and nutrient feed. In-situ bioremediation is generally not applicable to sites with free product or high contaminant concentrations.

Biodegradation can be conducted under aerobic conditions by supplying a sufficient source of oxygen or under anaerobic conditions by removing oxygen from the subsurface. The conditions chosen (i.e., aerobic or anaerobic) are dependent on the chemical compounds to be remediated and ease of implementation. BTEX, petroleum hydrocarbons, and SVOCs are known to be more susceptible to aerobic biodegradation, and chlorinated solvents generally degrade better under anaerobic biodegradation. Incomplete anaerobic biodegradation of chlorinated compounds can lead to the formation of intermediate compounds that are more toxic. Biodegradation may also cause sorbed phase contaminants to become mobile and in the short-term result in higher dissolved phase concentrations and potential for downgradient migration.

The following parameters can aid in evaluating the effectiveness and implementability of in-situ treatment:

- Hydrology/aquifer characteristics.
- Geochemical/water quality conditions.
- Nature of contaminants.
- Presence of biodegradable compounds (measured by oxygen demand for oxidation), nutrients (nitrogen and phosphorus), micronutrients (trace metals, salts, sulfur), calcium and TDS.
- Composition and activity of native microbial communities.

Aerobic Bioremediation

Aerobic bioremediation involves stimulation of indigenous aerobic microflora in the subsurface to enhance the biodegradation of contaminants by providing a supply of oxygen and nutrients. In some cases, a cometabolite or an additional carbon source is necessary to achieve biodegradation. Oxygen may be provided in the form of air, pure oxygen, hydrogen peroxide, or oxygen release compound (ORC®). The oxygen may either be added to extracted groundwater prior to reinjection, directly bubbled in through spargers (air sparging), or supplied by in-line injection of pure oxygen. The use of hydrogen peroxide leads to certain advantages such as a greater supply of oxygen and control of biofouling of the well.

Nutrients such as nitrogen and phosphate are essential for microorganisms and may be present in limited concentrations in the subsurface. The forms of nitrogen and phosphorus are not critical. However, the decision to add salts as nutrients must be based not only on laboratory tests for microbes, but also on potential interaction with the site geochemistry. Certain nutrients such as phosphates could result in the precipitation of calcium phosphate, which may clog pores and reduce the permeability of the subsurface. If the contamination is relatively low, it may be necessary to add an additional carbon source to support sufficient bacterial growth. The selection of this additional carbon source is critical. The compound selected must not be preferentially biodegraded over the COCs. In addition, the compound should be innocuous so that it will not adversely affect the groundwater. Other microbial nutrients such as potassium, magnesium, calcium, sulfur, sodium, manganese, iron, and trace metals may be already present in the groundwater.

The amount and extent of bioremediation would be dependent on the success of achieving adequate dispersion of nutrients and oxygen, which are vital factors for bioremediation. Aquifer conditions and distribution methods (injection points, injection wells, etc.) have a significant impact on adequate dispersion of nutrients and oxygen. In-situ biological degradation (in the aqueous phase) can be accomplished in combination with an extraction/recirculation system to reduce the total time of remediation.

Anaerobic Bioremediation

Anaerobic bioremediation involves stimulation of indigenous aerobic microflora in the subsurface to enhance the biodegradation of contaminants by providing a supply of hydrogen and nutrients. In some cases, a cometabolite or an additional carbon source is necessary to achieve biodegradation. Hydrogen may be provided in the form of hydrogen release compound (HRC®) or it can be generated by the addition and fermentation of lactate, molasses, or vegetable oil.

Similar to aerobic degradation, nutrients such as nitrogen and phosphorous may need to be added to foster anaerobic biodegradation. In addition, the amount and extent of bioremediation would be dependent on the success of achieving adequate dispersion of nutrients and hydrogen and anaerobic conditions capable of completely degrading the chlorinated solvents.

Effectiveness: Bioremediation should be effective for the treatment of most chlorinated solvents, BTEX, SVOCs, and petroleum hydrocarbons dissolved in groundwater at Site 6A, Site 10B, and the On-Site Southern Area Plume. Bioremediation is not typically effective if the source of groundwater contamination is not addressed first. The processes are proven, but extensive treatability work could be required. The reliability of bioremediation is dependent on how well amendments and nutrients are introduced and distributed through the aquifer. In some cases, multiple injections of amendments and nutrients are required to complete treatment, and in other cases, bioaugmentation is required to enhance the indigenous microorganism population to complete treatment. Extensive case studies are available involving the use of HRC® and ORC®. It is likely that anaerobic treatment of chlorinated solvents dissolved in groundwater with HRC® followed by aerobic treatment of the remaining BTEX, SVOCs, and petroleum hydrocarbons with ORC® would be effective for the sites. Groundwater monitoring would be required to determine the progress of bioremediation.

Implementability: Bioremediation should be implementable. Permits may be required for the injection of amendments (HRC® and ORC®) and nutrients into the aquifer, and because the aquifer is a sole-source aquifer, the permits may be difficult to obtain. There are only a limited number of vendors of HRC®- and ORC®-type products, although there are a sufficient number to perform this work.

Cost: The costs associated with bioremediation are proportional to the volume of groundwater to be treated, amount of amendments, and number of treatments required to completely treat the contaminated groundwater. The costs would be moderate when compared to other technologies.

Conclusion: Bioremediation using HRC® and ORC® will be retained for further consideration for the dissolved contaminants in groundwater at Site 6A, Site 10B, and the On-Site Southern Area Plume. Remediation of the source of the contamination (smear zone soil) will improve the effectiveness of bioremediation. It is unlikely that bioremediation could effectively address the contamination present in the smear zone soil.

4.3 DEVELOPMENT OF CORRECTIVE MEASURES ALTERNATIVES

The following sections provide the development of Corrective Measures Alternatives to address the contaminated media at Site 6A, Site 10B, and On-Site Southern Plume. Alternatives were developed to address soil and groundwater contamination at the sites independently. In addition, separate alternatives were developed for groundwater in the source areas at Sites 6A and 10B and groundwater in the On-site Southern Area Plume.

4.3.1 <u>Sites 6A and 10B Soil</u>

The following information is known about the soil contamination at Sites 6A and 10B and was used to select appropriate Corrective Measures Alternatives. Volume and mass calculations for soil are provided in Appendix B.

Site 6A

The approximate extent of soil contamination is shown on Figure 2-9. The size of the area is approximately 41,640 square feet. The estimated volume of petroleum-contaminated soil is 3,090 cubic yards and approximately 410 cubic yards of the soil is contaminated with PCBs (120 cy of PCB-contaminated soil also contains petroleum contamination). The volume of relatively clean soil that overlies the 3,380 cy of contaminated soil is 7,420 cubic yards. The contaminated soil is generally present between 5 and 7 feet bgs.

The soil COCs and PRGs are provided in Section 3.3.1 and Table 3-4. There is an estimated 45,810 pounds (the equivalent of 6,100 gallons) of organic contaminants present in the soil, the majority of which is adsorbed onto soils. Of this total, there is an estimated 130 pounds are chlorinated solvents, 100 pounds are BTEX, 110 pounds are PAHs, and 130 pounds are PCBs.

Free product samples were analyzed and determined to be a hazardous waste for chlorinated solvents and a TSCA waste. If any free product is removed/collected during corrective measures, it will need to be tested and disposed according to State and federal regulations. Because the free product may have resulted in high contaminant concentrations in the soil, it was assumed that up to 50 percent of the contaminated soil would be classified as hazardous/TSCA waste and the remaining 50 percent would be nonhazardous waste. Contaminant concentrations in the contaminated soil classified as hazardous waste are expected to be higher than LDRs; therefore, soil will require treatment prior to disposal. Additional testing would be necessary to confirm these assumptions.

Reinforced concrete (1 foot thick) covers approximately 8,520 square feet of contaminated soil, resulting in a total of approximately 320 cubic yards of concrete that will need to be addressed.

Site 10B

The approximate extent of soil contamination is shown on Figure 2-8. The size of the area is approximately 10,300 square feet. The estimated volume of contaminated soil is 770 cubic yards, and the volume of relatively clean soil that overlies the contaminated soil is 2,100 cubic yards.

The soil COCs and PRGs are provided in Section 3.3.1. There is an estimated 18,000 pounds (the equivalent of 2,500 gallons) of petroleum hydrocarbons present in the soil, the majority of which is adsorbed onto soils.

Because the contaminants are expected to be fuel-related, it was assumed that all of the contaminated soil would be classified as nonhazardous waste and that it could be disposed of or reused without pretreatment. Additional testing would be necessary to confirm these assumptions.

Reinforced concrete (1 foot thick) covers approximately 6,500 square feet of contaminated soil, resulting in a total of approximately 240 cubic yards of concrete that will need to be addressed.

A steel building with an area of approximately 3,800 square feet covers some of the contaminated soil.

4.3.1.1 Alternative S1: No Action

The No Action alternative maintains site conditions at the status quo. This alternative is retained to provide a baseline for comparison to other alternatives; therefore, it does not address the contamination in the soil. There would be no reduction in toxicity, mobility, or volume of contaminants in soil at Sites 6A and 10B from treatment other than that which would result from biodegradation or other attenuating factors. Any existing remedial activities, monitoring programs, and institutional controls would be discontinued, and the property would be available for unrestricted use.

4.3.1.2 Alternative S2: Land Use Controls/Deed Notifications and Monitoring

This alternative consists of implementing land use controls/deed notifications at Sites 6A and 10B and performing soil monitoring at both sites. Land use controls would be implemented by the Navy while it maintains ownership of the property. Deed notifications would be incorporated into the facility transfer documents when the property is sold by the Navy. These controls would restrict access and use of contaminated soil across approximately 41,640 square feet (0.96 acres) at Site 6A and approximately 10,300 square feet (0.2 acre) at Site 10B to minimize risks to human health and the environment. An investigation would be conducted at both sites to confirm the extent of contamination and the COCs. The investigation would be conducted using DPT, and approximately 30 soil samples would be collected at each site for analyses. Each sample would be analyzed for VOCs, SVOCs, PAHs, TPH-DRO, pesticides/PCBs, and TCLP metals.

This alternative also includes monitoring of contaminant concentrations in the soil as they degrade by natural processes. The monitoring is necessary to determine when the controls on the soil can be removed. Approximately four soil samples would be collected from each site during each soil monitoring event using DPT. Soil sample locations for monitoring are shown on Figure 4-1. The samples would be analyzed for VOCs, SVOCs, PAHs, PCBs, and TPH-DRO. A total of 7 soil sampling events would be conducted including a baseline event and six rounds of sampling at 5-year intervals for the next 30 years. This sampling would be performed in accordance with state and Federal regulations and would measure changes in contaminant concentrations. A re-evaluation of the site would be performed every 5 years to determine if any changes to the controls or remedy would be required.

4.3.1.3 Alternative S3: Excavation and Off-Site Treatment and Disposal

This alternative includes delineation and excavation of contaminated soil in excess of PRGs at Sites 6A and 10B and subsequent off-site treatment and disposal. Prior to conducting the excavation alternative, a pre-design investigation would be conducted at both sites to confirm the extent of contamination and the COCs. The investigation would be conducted using DPT, and approximately 30 soil samples would be collected at each site for analyses. Each sample would be analyzed for VOCs, SVOCs, PAHs, TPH-DRO, pesticides/PCBs, and TCLP metals.

Excavation at Site 6A will require the removal of approximately 320 cubic yards of reinforced concrete, 7,420 cubic yards of uncontaminated soil, and 3,380 cubic yards of contaminated soil. The water table is expected to be at 7 feet bgs, and the contaminated soil is expected to be just above the water table at 5 to 7 feet bgs. It is assumed that during excavation an additional 2,320 cy of adjacent soil will be disposed off site as non-hazardous waste.

The reinforced concrete at the site will be demolished into manageable pieces and stockpiled on site. The concrete will be tested for disposal purposes and disposed/re-used offsite as appropriate. It was assumed that all of the concrete will be nonhazardous waste. Next, the uncontaminated soil will be excavated and stockpiled on site. Additional uncontaminated soil may need to be excavated to form stable sidewalls of the excavation. Visual observations (e.g., staining) and field instruments would be used to identify uncontaminated versus contaminated soil. Laboratory analyses would subsequently be used to confirm that contaminant concentrations in the uncontaminated soil are below PRGs. The contaminated soil will then be excavated and staged on a dewatering pad. Excavation would continue below the water table if it is encountered. Any free liquids (water or free product) in the contaminated soil will be allowed to drain from the soil and will be collected. Free product will be separated from the water, and the liquids will be tested and disposed off site according to State and federal regulations. It was assumed that the free product will be hazardous/TSCA regulated and the water will be nonhazardous. If the water table is encountered during the excavation and free product is present on the water table, measures would be taken to recover the product and it would be disposed with the other free liquids collected from soil dewatering activities. The contaminated soil will be tested, and depending on the results (hazardous/nonhazardous), transported to a treatment and/or disposal facility. It was assumed that 50 percent of the contaminated soil will be hazardous and 50 percent will be nonhazardous. Testing would be necessary to confirm these assumptions and verification sampling would be required to confirm the removal of contaminants in excess of PRGs. After excavation is complete, the uncontaminated soil (7,420 cubic yards) and additional clean fill from off-site sources (approximately 3,380 cubic yards) will be used to fill the excavation and restore the site. It was assumed that the restored surface at the site will be grass and not concrete.

A similar sequence of activities would be conducted for Site 10B soil. Excavation at Site 10B will require the removal of a steel building and approximately 240 cubic yards of reinforced concrete, 1,860 cubic yards of uncontaminated soil, and 770 cubic yards of contaminated soil. The water table is expected to be at 10 feet bgs, and the contaminated soil is expected to be between 4 and 10 feet bgs. All of the concrete and contaminated soil at Site 10B is assumed to be nonhazardous. It is unlikely that significant amounts of free product will be recovered from the contaminated soil or will be present on the groundwater table if it is encountered during excavation activities. Verification samples would be collected to confirm the removal of contaminants in excess of PRGs. After excavation is complete, the uncontaminated soil (1,860 cubic yards) and additional clean fill from off-site sources (approximately 1,000 cubic yards) will be used to fill the excavation and restore the site. It was also assumed that the restored surface at the site will be grass and not concrete.

There would be no restrictions related to soil at Sites 6A and 10B after Alternative S3 is completed. Five-year reviews would not be required.

4.3.1.4 Alternative S4: Excavation, On-Site Treatment (Thermal), and On-Site Re-Use

This alternative would include the same delineation and excavation components (including verification sampling) as Alternative S3. The excavated contaminated soil from both Sites 6A and 10B would be staged on site on a dewatering pad. Any free liquids (water or free product) in the contaminated soil will be allowed to drain from the soil and will be collected. Free product will be separated from the water, and the liquids will be tested and disposed off site according to State and federal regulations. The contaminated soil will then be treated in a thermal treatment unit.

A mobile high-temperature thermal unit would be mobilized to the site to conduct the treatment. A schematic of the thermal treatment process is shown on Figure 4-2. The high-temperature unit is necessary to treat the PAHs and PCBs in the soil at Site 6A. The unit would also be capable of treating the other COCs (BTEX, chlorinated solvents, and hydrocarbons) in the soil. The efficiencies of the system should allow the contaminated soil to be treated to the PRGs and re-used on site. Additional soil characterization and treatability studies would be required to design the appropriate treatment system (temperatures, residence times, and off-gas treatment). Permits would be required to operate the unit on site.

Approximately 7.340 cubic yards of soil would be treated under this alternative. This volume includes 4,150 cy of contaminated soil and 3,190 cy of adjacent soils excavated with the contaminated soil.

Assuming that 210 cubic yards can be treated per day, it would take approximately 35 days (working) or approximately 2 months to treat all of the soil on site. Approximately 600 cubic yards of clean fill would still be required for site restoration to replace the concrete that was removed. Residual waste generated from the treatment of the off-gas would need to be transported and disposed off site. After all of the soil is treated, the mobile thermal unit would be demobilized from the site.

There would be no restrictions related to soil at Sites 6A and 10B after Alternative S4 is completed. Five-year reviews would not be required.

4.3.1.5 Alternative S5: Institutional Controls/Deed Notifications, In-Situ Treatment (Soil Vapor Extraction), and Monitoring

Under Alternative S5, the contaminated soil at Sites 6A and 10B would be treated in-situ using SVE. This alternative would include the same delineation component as Alternative S2. The SVE systems should be very effective for chlorinated solvents and BTEX in soil and moderately effective on PAHs, SVOCs, and petroleum hydrocarbons. SVE would not be effective for the PCBs in the soil at Site 6A. Separate SVE systems would be installed and operated at Sites 6A and 10B.

The land use controls/deed notifications discussed in Alternative S2 would need to be implemented until treatment of the contaminated soil by SVE is completed and contaminant concentrations have decreased to less than PRGs. SVE treatment is expected to take up to 4 years. The PCBs in the Site 6A soil are expected to remain for more than 30 years.

The layouts of the Sites 6A and 10B SVE systems are shown on Figure 4-3, and a schematic of the alternative is shown on Figure 4-4. Calculations for the systems are provided in Appendix C. The systems include extraction trenches, an extraction pump with moisture separator, and a GAC off-gas treatment system. Trenches were selected over wells for the SVE systems due to the shallow water table. Additional issues regarding the shallow water table would need to be considered during the design phase of the SVE systems. The spacing between the trenches would be designed to ensure that there are no contaminated areas left untreated while at the same time, preventing too much overlap of zones of influence of individual wells. The trenches for Sites 6A and 10B would be sized to address both the soil and groundwater contamination at the sites because it was assumed that air sparging systems would also be installed to treat groundwater contamination. Approximately 10 extraction trenches, each 500 feet long, would be installed for the Site 6A system, and approximately 5 extraction trenches, each 200 feet long, would be installed for the Site 10B system. The Site 6A extraction pump system would be a vacuum pump rated for 900 cubic feet per minute (cfm) and include one moisture separator. The Site 10B extraction pump system would be a vacuum pump rated for 250 cfm and include one moisture separator. Each of the offgas treatment systems would include two GAC units holding 13,600 pounds of

GAC each. GAC was selected as a representative process option for offgas treatment based on anticipated air stream contaminant concentrations. Other options would include combustion or catalytic destruction. The spent GAC would be regenerated/treated off site. It was assumed that the systems would be operational for up to 4 years. The rate of GAC consumption would provide an indication of the success of contaminant removal by SVE.

This alternative also includes air monitoring of emissions from the offgas treatment systems and soil/soil gas monitoring to track contaminant concentration decreases as a result of the SVE treatment. The air monitoring is required to ensure protection of human health and the environment. Air discharge permits would be obtained as necessary. It was assumed that air monitoring would be conducted frequently (weekly) during the startup phases of the systems (1 month) and then reduce to monthly there after for the duration of the remediation. The air samples will be analyzed for VOCs.

The soil monitoring is necessary to determine when the SVE systems can be shut down and land use controls/deed notifications on the soil can be removed. Approximately four soil samples would be collected using DPT from each site annually for 4 years while the SVE system is operational (see Figure 4-3). The samples would be analyzed for VOCs, SVOCs, PAHs, PCBs, and TPH-DRO. A total of five soil sampling events would be conducted including a baseline event and four additional rounds. The soil sampling would be performed in accordance with State and federal regulations and would measure changes in contaminant concentrations. Soil gas monitoring would also be conducted using field instruments to help determine the effectiveness of the system. Soil monitoring at Site 6A for PCBs would continue after the SVE system is shut down. Approximately four soil samples would be collected from the site every 5 years and analyzed for PCBs. The monitoring would be conducted for 30 years.

It was assumed that the SVE systems will address a majority of the soil contamination (chlorinated solvents, BTEX, SVOCs, PAHs, and other petroleum hydrocarbons) within 4 years. Five-year reviews for the soil at Site 10B would not be required, but reviews would be required for the PCB-contaminated soil remaining at Site 6A.

4.3.1.6 Alternative S6: Institutional Controls/Deed Notifications, Monitoring, and Excavation of PCB-Contaminated Hot Spots and Off-Site Treatment/Disposal

This alternative is similar to Alternative S2 because it includes implementing land use controls/deed notifications at Sites 6A and 10B and performing soil monitoring at both sites. However, this alternative also includes excavation of the PCB-contaminated hot spots at Site 6A and off-site treatment and disposal.

Land use controls would be implemented by the Navy while it maintains ownership of the property. Deed notifications would be incorporated into the facility transfer documents when the property is sold by the Navy. These controls would restrict access and use of contaminated soil across approximately 41,640 square feet (0.96 acres) at Site 6A and approximately 10,300 square feet (0.2 acre) at Site 10B to minimize risks to human health and the environment. No controls would be required for approximately 4,200 square feet (0.1 acres) at Site 6A where the PCB-contaminated hot spots were excavated. An investigation would be conducted at both sites to confirm the extent of contamination and the COCs. The investigation would be conducted using DPT, and approximately 30 soil samples would be collected at each site for analyses. Each sample would be analyzed for VOCs, SVOCs, PAHs, TPH-DRO, pesticides/PCBs, and TCLP metals.

This alternative includes monitoring of contaminant concentrations in the soil remaining at Sites 6A and 10B as they degrade by natural processes. The monitoring is necessary to determine when the controls on the soil can be removed. Approximately four soil samples would be collected from each site during each soil monitoring event using direct-push technology (DPT). Soil sample locations for monitoring are shown on Figure 4 1. The samples would be analyzed for VOCs, SVOCs, PAHs, and TPH-DRO. A total of seven soil sampling events would be conducted including the baseline event mentioned above and six rounds of sampling at 5-year intervals for the next 30 years. This sampling would be performed in accordance with state and Federal regulations and would measure changes in contaminant concentrations. A re-evaluation of the site would be performed every 5 years to determine if any changes to the controls or remedy would be required.

Approximately 420 cubic yards of PCB-contaminated soil covering approximately 4,200 square feet (0.1 acres) is present at Site 6A. The extent of the contamination will be refined during subsequent investigations. Excavation at Site 6A will require the removal of approximately 100 cubic yards of uncontaminated soil, and 8 cubic yards reinforced concrete will need to be removed to access the PCB-contaminated soil. The water table is expected to be at 7 feet bgs, and the contaminated soil is expected to be just above the water table at 5 to 7 feet bgs. The uncontaminated soil will be excavated and stockpiled on site. Additional uncontaminated soil may need to be excavated to form stable sidewalls of the excavation. Visual observations (e.g., staining) and field instruments would be used to identify uncontaminated versus contaminated soil. Laboratory analyses would subsequently be used to confirm that contaminant concentrations in the uncontaminated soil are below the PRG. The contaminated soil will then be excavated and staged on a dewatering pad. Excavation would continue below the water table if it is encountered. Any free liquids (water or free product) in the contaminated soil will be allowed to drain from the soil and will be collected. Free product will be separated from the water, and the liquids will be tested and disposed off site according to State and federal regulations. It was assumed that the free product will be hazardous/TSCA regulated and the water will be nonhazardous. If the water table is encountered during the excavation and free product is present on the water table, measures would be taken to recover the product and it would be disposed with the other free liquids collected from soil dewatering activities. The contaminated soil will be tested, and depending on the results (hazardous/nonhazardous), transported to a treatment and/or disposal facility. It was assumed that 50 percent of the contaminated soil will be hazardous and 50 percent will be nonhazardous. Testing would be necessary to confirm these assumptions. After excavation is complete, the uncontaminated soil (110 cubic yards) and additional clean fill from off-site sources (approximately 420 cubic yards) will be used to fill the excavation and restore the site. It was assumed that the restored surface at the site will be grass.

There would still be restrictions related to soil at Sites 6A and 10B after Alternative S6 is completed and five year reviews would be required.

4.3.1.7 Alternative S7: Excavation of PCB-Contaminated Hot Spots and Off-Site Treatment/ Disposal and In-Situ Treatment of Petroleum- and Solvent-Contaminated Soil by ISCO

This alternative involves in-situ treatment of the petroleum- and solvent-contaminated soil at Sites 6A and 10B by ISCO. This alternative also includes excavation of the PCB-contaminated hot spots at Site 6A and off-site treatment and disposal. No land use controls, deed notifications, or monitoring should be required after implementation of this alternative. An investigation would be conducted at both sites to confirm the extent of contamination and the COCs. The investigation would be conducted using DPT, and approximately 30 soil samples would be collected at each site for analyses. Each sample would be analyzed for VOCs, SVOCs, PAHs, TPH-DRO, pesticides/PCBs, and TCLP metals.

Excavation of the PCB-contaminated soil at Site 6A would be conducted first. The excavation and disposal process would be the same as the process followed under Alternative S6.

The petroleum- and solvent-contaminated soil remaining at Sites 6A and 10B would be treated in-situ using ISCO. A bench-scale treatability study and a pilot study would be completed prior to full-scale implementation of ISCO. Field surveys would be completed to locate underground utilities that may be impacted by the treatment. The full-scale treatment process would involve injecting an oxidant/activator slurry capable of treating both petroleum and solvents [e.g., REGENOX® (sodium percarbonate) from Regenesis] via DPT into the contaminated soil smear zone at the water table. It is expected that three treatments with the oxidant/activator will be required to reduce the contaminant mass in the soil by approximately 90 percent. This amount of reduction is required to reach most of the soil PRGs. Approximately 5.6 million pounds of oxidant/activator would be necessary to treat Site 6A soil and 1.8 million pounds would be required to treat Site 10B soil. The oxidant would be injected through approximately 1,000 injection points using DPT during each treatment. Each treatment would take approximately 30 days to complete. An air monitoring program would be conducted during the treatment to determine if any contaminant vapors are migrating into inhabited buildings. Monitoring would be conducted monthly for approximately 1 year. Two rounds of soil samples would be collected at each site to confirm the success of the treatment. The samples would be collected at 3 and 6 months after the final treatment.

Implementation of this alternative would take approximately 2 years. There would be no restrictions related to soil at Sites 6A and 10B after Alternative S7 is completed and no five-year reviews would be required.

4.3.2 Sites 6A and 10B Groundwater

The following information is known about the groundwater contamination at Sites 6A and 10B and was used to select appropriate Corrective Measures Alternatives:

Site 6A

The approximate extent of groundwater contamination is shown on Figure 2-9. The size of the area is approximately 100,000 square feet. The estimated volume of contaminated groundwater is 5.6 million gallons. The water table is approximately 7 feet bgs at Site 6A.

The groundwater COCs and PRGs are provided in Section 3.3.2 and Table 3-2. There is an estimated 5 pounds of dissolved organic contaminants present in the groundwater. Of this total, there are approximately 3 pounds of chlorinated solvents and 2 pounds of BTEX and other VOCs present. Based on historic data, there is less than one pound of SVOCs present.

Site 10B

The extent of groundwater contamination is shown on Figure 2-9. The size of the area is approximately 25,200 square feet. The estimated volume of contaminated groundwater is 943,000 gallons. The groundwater COCs and PRGs are provided in Section 3.3.2 and Table 3-3. There is an estimated 0.8 pound of fuel-related contamination present in the groundwater.

For alternative development and identification, the groundwater at Sites 6A and 10B were identified as Source Area Groundwater (SAGW).

4.3.2.1 Alternative SAGW1: No Action

The No Action alternative maintains the sites at the status quo. This alternative is retained to provide a baseline for comparison to other alternatives; it does not address the contamination in the groundwater. There would be no reduction in toxicity, mobility, or volume of the contaminants in the groundwater at Sites 6A and 10B from treatment other than that which would result from natural dispersion, dilution, biodegradation, or other attenuating factors. Any existing remedial activities, monitoring programs, and institutional controls would be discontinued, and the property would be available for unrestricted use.

4.3.2.2 Alternative SAGW2: Land Use Controls/Deed Notifications, Natural Attenuation, and Monitoring

This alternative consists of implementing land use controls/deed notifications at Sites 6A and 10B and performing groundwater monitoring to track natural attenuation of contamination. Calculations for this alternative are provided in Appendix B.

Land use controls would be implemented by the Navy while it maintains ownership of the property. Deed notifications would be incorporated into the facility transfer documents when the property is sold by the Navy. These controls would restrict access and use of the contaminated groundwater in an area of approximately 100,000 square feet (2.3 acres) at Site 6A and 25,200 square feet (0.6 acre) at Site 10B to minimize risks to human health and the environment.

This alternative would also monitor decreases in groundwater contaminant concentrations through natural processes. Previous groundwater modeling predicted that if the source of contamination at Site 6A was not addressed, it would require up to 100 years for natural attenuation to address the groundwater contamination (toluene and xylene). If the contaminant source was removed (90 percent), the modeling predicted that contaminant concentrations in groundwater may attenuate to PRGs in less than 10 years. For evaluation purposes, it was assumed that a majority of the source of contamination at both sites would be addressed and that groundwater remediation would occur within 30 years at Site 6A and 10 years at Site 10B. The differences in clean-up times are related to the amount of product/contaminant source detected at each site. Actual remediation times may vary from these assumed times.

Approximately six existing monitoring wells (FC-MW-01S, FC-MW-02S, FC-MW-03S, FC-MW-05S, FC-MW-06S, and FC-MW-07S) and two new monitoring wells would be included in the network for the Site 6A monitoring program (see Figure 4-5). Groundwater monitoring would be conducted quarterly at the eight wells for the first year to understand seasonal trends and provide a baseline data set for the site. Monitoring would be conducted annually in the eight monitoring wells for the next 29 years. For Site 10B, four new monitoring wells would be installed for the monitoring program. The approximate locations of these wells are shown on Figure 4-5. The four new monitoring wells at Site 10B would be sampled quarterly for the first year and then annually for the next 9 years. It was assumed that the groundwater samples from both sites would be analyzed for VOCs, SVOCs, PAHs, and water quality parameters. Free product measurements would also be taken during each monitoring event. The water quality parameters that would be measured in the field include temperature, turbidity, specific conductivity, oxidation-reduction potential, dissolved oxygen, pH, and divalent iron. The water quality parameters that would be measured by a laboratory include methane, carbon dioxide, ethene, ethane, chloride, nitrate, sulfate, and sulfide. The analytical program would be optimized during the duration of the monitoring program. All well installation and groundwater sampling activities would be performed in accordance with State and federal regulations.

Groundwater analytical data would be reviewed periodically to evaluate the effectiveness of the natural attenuation. Additional groundwater contaminant fate and transport modeling would be conducted as necessary to predict contaminant migration and natural attenuation. A re-evaluation of the site would be performed every 5 years as long as contaminant concentrations are greater than PRGs to determine if any changes to the controls or remedy would be required.

4.3.2.3 Alternative SAGW3: Land Use Controls/Deed Notifications, Groundwater Extraction (Wells), Treatment (Air Stripping/Activated Carbon), Re-Injection (Infiltration Galleries), and Monitoring

This alternative consists of implementing land use controls/deed notifications at Sites 6A and 10B, extracting the contaminated groundwater, treating and reinjecting the water, and monitoring the progress of groundwater remediation. Calculations for this alternative are provide in Appendix B.

Land use controls/deed notifications would be implemented on the sites as discussed in Alternative SAGW2 to minimize risks to human health and the environment.

Separate groundwater extraction and treatment systems would be installed for Sites 6A and 10B. The layouts of the extraction systems are shown on Figure 4-6. A schematic of the general treatment system for the sites is shown on Figure 4-7. Groundwater extraction systems can be developed for source area treatment, downgradient plume containment, and a combination of both. This alternative was developed to remediate and contain the contaminated groundwater at the sites. Previous groundwater fate and transport modeling completed for Site 6A predicted that contaminated groundwater would not migrate more than 1,500 feet downgradient from the source area. Therefore, containment was not a primary concern at the site; however, it was incorporated into the alternative to be conservative. Similar to Alternative SAGW2, it was assumed for this alternative that the source of contamination to groundwater (soils/free product) would be remediated.

Based on preliminary calculations, the Site 6A extraction system would include four 6-inch extraction wells and the Site 10B extraction system would include two 6-inch wells. All of the wells would be placed in the middle of the plumes along a line parallel with the direction of groundwater flow (see Figure 4-6). The wells would be constructed to capture groundwater from the entire overburden aquifer (approximately 10 to 60 feet bgs). The Site 6A wells would extract a total of approximately 80 gpm of contaminated groundwater, and it was estimated that the system would be operational for 30 years. The actual duration that the extraction system is operational is expected to vary between 7 years (xylenes) and 30 years (naphthalene). The Site 10B wells would extract a total of approximately 40 gpm of contaminated groundwater and it is estimated to be operational for approximately 9 years. The actual duration that the Site 10B system would be operational is also expected to vary.

Extracted groundwater would be treated to meet PRGs prior to reinjection. The typical groundwater treatment system schematic is shown in Figure 4-7 and consists of the following unit operations/processes: equalization/chemical precipitation, clarification, filtration, and air stripping. A treatability test would be conducted on each system to confirm that they treat the groundwater to the required PRGs. The treatment system for Site 6A would be separate from Site 10B. An oil-water separator may also be needed for Site 6A groundwater.

In general, the groundwater extracted from both sites would be transferred to an equalization tank to dampen flow and contaminant surges. The equalization tank would be designed to provide 30 minutes of detention under design flow conditions. Caustic would be added for pH control, and permanganate would be added for iron and manganese oxidation. Precipitated metals would be removed in the clarifier. The precipitate would then be disposed off site. The clarified water would be pumped to a bag filter for suspended solids removal and then to an air stripper. A low-profile multi-tray air stripper would be used for VOC removal. It is likely that some SVOCs and PAHs would also be removed by the air stripper. Alternately, liquid-phase GAC could be used. Based on the low VOC concentrations in the groundwater, offgas treatment would probably not be required for either system. After treatment, the effluent would be reinjected to the overburden aquifer via injection galleries placed upgradient of the source area plumes. The general layout of the injection galleries are shown on Figure 4-6. The infiltration galleries would be sized to accommodate the system flow rates. Effluent monitoring of each system would be conducted weekly for the first month of operation and then monthly for the duration of each systems operation (30 years and 9 years, respectively). The effluent samples would be analyzed for VOCs, SVOCs, and PAHs.

Groundwater monitoring at both Sites 6A and 10B would be conducted quarterly for the first year and then annually thereafter to monitor the progress of groundwater remediation. Eight wells at Site 6A [four extraction wells and four existing wells (FC-MW-02S, FC-MW-05S, FC-MW-06S, and FC-MW-07S)] and four wells at Site 10B (two extraction wells and two new monitoring wells) would be sampled as part of the monitoring programs (see Figure 4-6). The groundwater extraction systems would be shut down during the monitoring events. The groundwater samples would be analyzed for VOCs, SVOCs, and PAHs. The field water quality parameters included in Alternative SAGW2 would also be collected during each sampling event. Groundwater analytical data would be reviewed periodically to evaluate the effectiveness of the groundwater extraction systems. If the results of the monitoring show that the groundwater extraction system(s) are not effective at reaching the groundwater PRGs, the systems would be shut down and a remedy similar to Alternative SAGW2 (institutional controls, natural attenuation, and monitoring) would be implemented. However, for this alternative, it was assumed that the remedy would not change and that the Site 6A and Site 10B systems would be operational for 30 years and 9 years, respectively.

4.3.2.4 Alternative SAGW4: Land Use Controls/Deed Notifications, In-Situ Treatment (Air Sparging), and Monitoring

Alternative 4 was developed as an in-situ treatment alternative. This alternative consists of implementing land use controls/deed notifications at Sites 6A and 10B, installing air sparging/bioventing systems, and conducting groundwater monitoring. Air would be injected in the areas of contaminated groundwater, and the layout of the systems is shown on Figure 4-8. A schematic of the air sparing system is present in Figure 4-4. Calculations for this alternative are presented in Appendix B.

Land use controls/deed notifications would be implemented on the sites as discussed in Alternative SAGW2 to minimize risks to human health and the environment until the PRGs are reached.

Generally, alternative development would consider options for source area treatment, downgradient plume containment, and a combination of both. This approach results from many sites having a relatively small area of higher-level contamination (source area) and a relatively large area of lower-level contamination (downgradient area). This alternative includes only one option consisting of groundwater treatment in the source area and downgradient area.

Separate air sparging systems would be developed for Sites 6A and 10B (see Figure 4-8). Approximately 600 cfm and 160 cfm of air would be injected into the saturated zones at Sites 6A and 10B, respectively. The air would be injected through 51 injection wells at Site 6A and 13 injection wells at Site 10B. The wells would be installed to depths of 15 to 20 feet below the water table. Air injection causes volatilization of VOCs and some SVOCs and PAHs in groundwater and also supplies oxygen to enhance biodegradation in the groundwater and capillary zone. Air sparging/bioventing is usually used in combination with SVE. Vapor extraction in the vadose zone removes contaminant vapors released from the groundwater and contaminated soils in the vadose zone, as well as biodegradation products (mainly carbon dioxide and water). Alternative S5 provides the details for the SVE systems for Sites 6A and 10B. The combination of Alternatives SAGW4 and S5 may be able to address groundwater and soil contamination at both sites.

Similar to Alternative S5, it was assumed that the air sparging systems would address the groundwater contamination within 4 years; therefore, 5-year reviews for the groundwater under this alternative should not be required. If after 4 years of operation, groundwater clean-up is not complete or contaminant removal via the air sparge systems has become inefficient, the systems would be shut down and a remedy similar to Alternative SAGW2 (institutional controls, natural attenuation, and monitoring) would be implemented. However, for this alternative it was assumed that groundwater clean-up will occur within the 4-year period.

Approximately six existing monitoring wells (FC-MW-01S, FC-MW-02S, FC-MW-03S, FC-MW-05S, FC-MW-06S, and FC-MW-07S) at Site 6A and four new monitoring wells at Site 10B would be included in the networks for the monitoring programs (see Figure 4-5). Groundwater monitoring would be conducted quarterly for the first year and then annually for the next 3 years. It was assumed that groundwater samples from both sites would be analyzed for VOCs, SVOCs, PAHs, and water quality parameters. Free product measurements would also be taken during each monitoring event. The air sparge systems would be shut down prior to each round of groundwater monitoring. The water quality parameters that would be measured in the field include temperature, turbidity, specific conductivity, oxidation-reduction potential, dissolved oxygen, and pH. Groundwater analytical data would be reviewed periodically to evaluate the effectiveness of the air sparge systems.

4.3.2.5 Alternative SAGW5: Land Use Controls/Deed Notifications, In-Situ Biological Treatment (Biostimulation with HRC® and ORC®), Natural Attenuation, and Monitoring

Alternative SAGW5 was developed as an active in-situ bioremediation alternative. This alternative consists of implementing land use controls/deed notifications at Sites 6A and 10B, adding HRC® and/or ORC® to the overburden aquifer to biologically treat the COCs, and conducting groundwater monitoring. Calculations for this alternative are presented in Appendix B.

Land use controls/deed notifications would be implemented on the sites as discussed in Alternative SAGW2 to minimize risks to human health and the environment.

Groundwater treatment systems can be developed for source area treatment, downgradient plume containment, and a combination of both. This alternative was developed to remediate the contaminated groundwater at the sites. Previous groundwater fate and transport modeling completed for Site 6A predicted that contaminated groundwater would not migrate more than 1,500 feet downgradient from the source area. Therefore, containment was not a primary concern at the site; however, it was incorporated into the alternative to be conservative. Biological stimulation with HRC® and ORC® is generally most effective if used to address dissolved contaminants in the aquifer after the source of contamination has been addressed. Source area treatment with HRC® and ORC® is typically not cost effective because of the amount of amendments and number of treatments required. Therefore, similar to Alternative SAGW2, it was assumed for this alternative that the source of contamination to groundwater (soils/free product) would be remediated. A pilot study would be conducted to determine the effectiveness of biological stimulation prior to full implementation of the remedial alternative.

Separate groundwater treatments using HRC® and ORC® would be completed for Sites 6A and 10B. HRC® injections would be conducted first to enhance existing anaerobic degradation of the chlorinated solvents in the aquifer at Sites 6A and 10B. The HRC® would be injected over a grid at each site and the layouts of the injection points are shown on Figure 4-9. Calculations indicate that approximately 32,400 pounds of HRC® would need to be injected through 126 injection points (15-foot by 60-foot spacing) to address the Site 6A groundwater contaminants. The HRC® would be injected into the upper 30 feet of the overburden aquifer using DPT. At Site 10B, approximately 5,700 pounds of HRC® would need to injected through 30 injection points (15-foot by 60-foot spacing). The HRC® would be injected into the upper 20 feet of the overburden aquifer at this site using DPT. It was estimated that the HRC® treatment would be fully effective at treating the chlorinated solvents within 1 year.

After HRC® treatment, the groundwater at both sites would be allowed to return to aerobic conditions by natural processes for 1 year. After 1 year, the groundwater would be treated with ORC® to enhance biodegradation of BTEX, SVOCs, PAHs, and petroleum hydrocarbons. The addition of ORC® has been demonstrated to remediate fuel-contaminated groundwater. The ORC® would be applied at each site over a grid system using DPT injection, and the layouts of the injection points are shown on Figure 4-10. Approximately 21,000 pounds of ORC® would be injected at Site 6A and approximately 7,200 pounds of ORC® would be injected at Site 10B. It was assumed that one application of ORC® would treat the dissolved contaminants in groundwater.

As a contingency, it was assumed that after application of HRC® and ORC® that the groundwater would not be completely cleaned up and that a remedy similar to Alternative SAGW2 (institutional controls, natural attenuation, and monitoring) would be implemented. It was assumed that PRGs would be reached within 3 years after treatment or within a total of 6 years from initiation of the alternative. This assumption is based on model predictions that indicate that if a majority of the source (90 percent) was remediated, natural attenuation processes would reduce contaminant concentrations to PRGs in less than 10 years. Active treatment of the groundwater should reduce the clean-up time by several years.

Groundwater monitoring would be conducted to determine the effectiveness of the HRC® and ORC® injections. The monitoring well networks and analytical programs used for the monitoring programs would be similar to those in Alternative SAGW2 (see Figure 4-5). Groundwater sampling would be conducted quarterly for the first 3 years of the alternative when treatment is occurring and then annually for the next 3 years when natural attenuation is occurring. This sampling would be performed in accordance with State and federal regulations. A re-evaluation of the site would be performed after 5 years to determine if any changes to the remedy or controls would be required.

4.3.3 On-Site Southern Area Plume

The following information is known about the groundwater contamination in the On-Site Southern Area Plume and was used to select appropriate corrective measures alternatives:

- The extent of groundwater contamination in the On-Site Southern Area Plume is shown on Figure 2-10. The size of the area is approximately 86 acres. The estimated volume of contaminated groundwater is 209 million gallons. The groundwater COCs and PRGs are provided in Section 3.3.2 and Table 3-3. It was estimated that there is a total of 165 pounds of organic contamination (chlorinated solvents and other VOCs) present in the groundwater.

For alternative development and identification, the groundwater in the On-Site Southern Area Plume was identified as the On-Site Southern Area Groundwater Plume (OSAGP).

4.3.3.1 Alternative OSAGP1: No Action

The No Action alternative maintains the site at the status quo. This alternative is retained to provide a baseline for comparison to other alternatives; it does not address the contamination in the groundwater. There would be no reduction in toxicity, mobility, or volume of the contaminants in the On-Site Southern Area Plume by treatment other than that which would result from natural dispersion, dilution, biodegradation, or other attenuating factors. Existing remedial activities, monitoring programs, and institutional controls would be discontinued, and the property would be available for unrestricted use.

4.3.3.2 Alternative OSAGP2: Land Use Controls/Deed Notifications, Natural Attenuation, and Monitoring

This alternative consists of implementing land use controls/deed notifications for the On-Site Southern Area Plume and performing groundwater monitoring to track natural attenuation of contamination. Calculations for this alternative are provided in Appendix B.

Land use controls would be implemented by the Navy while it maintains ownership of the property. These controls would restrict access and use of the contaminated groundwater in the On-Site Southern Area Plume, which covers approximately 86 acres, to minimize risks to human health and the environment. These same land use controls would then be incorporated into facility transfer documents when the property is transferred by the Navy.

This alternative would also monitor decreases in groundwater contaminant concentrations through natural processes. Based on historical site information, it appears that the On-Site Southern Area Plume was created as a result of the reinfiltration of contaminated groundwater that was extracted from Site 6A during free product recovery efforts and discharged to the local surface water drainage ditches and/or periodic overland transport of contaminated surface water. Previous groundwater modeling predicted that if the source of contamination at Site 6A was not addressed, it would require up to 100 years for natural attenuation to address the groundwater contamination. Assuming the contaminant source was removed (90 percent), the modeling predicted that contaminant concentrations in groundwater at Site 6A may attenuate to PRGs in less than 10 years. For evaluation purposes, it was assumed that remediation of the On-Site Southern Area Plume would occur within 30 years.

Approximately ten new monitoring wells would be included in the network for the On-Site Southern Area Plume monitoring program. Groundwater monitoring would be conducted quarterly at the 10 new wells for the first year to understand seasonal trends and provide a baseline data set for the site. Monitoring would be conducted annually for the next 29 years. The approximate locations of these wells are shown on Figure 4-11. It was assumed that all groundwater samples would be analyzed for VOCs, SVOCs, PAHs, and field water quality parameters. The field water quality parameters that would be measured include temperature, turbidity, specific conductivity, oxidation-reduction potential, dissolved oxygen, pH, and divalent iron. Additional water quality parameters would be measured by a laboratory during the first year of sampling. These additional parameters include methane, carbon dioxide, ethene, ethane, chloride, nitrate, sulfate, and sulfide. It is expected that the analytical program would be optimized during the monitoring program. All well installation and groundwater sampling activities would be performed in accordance with State and federal regulations.

Groundwater analytical data would be reviewed periodically to evaluate the effectiveness of natural attenuation. Additional groundwater contaminant fate and transport modeling would be conducted as necessary to predict contaminant migration and natural attenuation. A reevaluation of the site would be performed every 5 years as long as contaminant concentrations are greater than PRGs to determine if any changes to the controls or remedy would be required.

4.3.3.3 Alternative OSAGP3: Land Use Controls/Deed Notifications, Groundwater Extraction (Wells), Treatment (Air Stripping/Activated Carbon), Reinjection (Infiltration Galleries), and Monitoring

This alternative consists of implementing land use controls/deed notifications for the On-Site Southern Area Plume, extracting the contaminated groundwater, treating and reinjecting the water, and monitoring the progress of groundwater remediation. Calculations for this alternative are provide in Appendix B.

Land Use Controls/deed notifications would be implemented for the On-Site Southern Area Plume similar to those implemented for Alternative OSAGP2. These controls would restrict access and use of the contaminated groundwater in the On-Site Southern Area Plume, which covers approximately 86 acres, to minimize risks to human health and the environment.

A groundwater extraction and treatment system would be installed to address the On-Site Southern Area Plume. The layout of the extraction system is shown on Figure 4-12 and a schematic of the treatment system is shown on Figure 4-7. Groundwater extraction systems can be developed for source area treatment, downgradient plume containment, and a combination of both. Due to the size of the On-Site Southern Area Plume, this alternative was mainly developed to contain and prevent off-site migration of the contaminated groundwater. However, if the system is operated long enough, it should also remediate the plume. It was assumed for this alternative that there are no significant remaining sources of contamination to groundwater (soils/free product).

Based on preliminary calculations, the extraction system would include five 6-inch extraction wells. All of the wells would be placed along the downgradient edge of the base boundary over the width of the plume (see Figure 4-12). The wells would be constructed to capture groundwater from the entire overburden aquifer (approximately 10 to 60 feet bgs). The On-Site Southern Area Plume wells would extract a total of approximately 200 gpm of contaminated groundwater, and it was estimated that the system would be operational for 11 years.

Extracted groundwater would be treated to meet PRGs prior to reinjection. The typical groundwater treatment system is shown in Figure 4-7 and consists of the following unit operations/processes: equalization/chemical precipitation, clarification, filtration, and air stripping. A treatability test would be conducted on the system for the On-Site Southern Area Plume to confirm that it treats the groundwater to the required PRGs.

In general, the groundwater extracted from the On-Site Southern Area Plume would be transferred to an equalization tank to dampen flow and contaminant surges. The equalization tank would be designed to provide 30 minutes of detention under design flow conditions. Caustic would be added for pH control, and permanganate would be added for iron and manganese oxidation. Precipitated metals would be removed in the clarifier. The precipitate would then be disposed off-site. The clarified water would be pumped to bag filter for suspended solids removal and then to an air stripper. A low-profile multi-tray air stripper would be used for VOC removal. It is likely that some SVOCs and PAHs would also be removed by the air stripper. Alternately, liquid phase granular activated carbon could be used. Based on the low VOC concentrations in the groundwater, off-gas treatment would probably not be required for the system. After treatment, the effluent would be reinjected to the overburden aquifer via injection galleries placed upgradient of the source area plumes. The layout of the injection galleries are shown on Figure 4-12. The infiltration galleries would be sized to accommodate the system flow rates. Effluent monitoring of the system would be conducted weekly for the first month of operation and then monthly for the duration of each systems operation (11 years). The effluent samples would be analyzed for VOCs, SVOCs, and PAHs.

Groundwater monitoring would be conducted quarterly for the first year and then annually thereafter to monitor the progress of groundwater remediation. Similar to Alternative OSAGP2, ten new monitoring wells would be installed and sampled as part of the monitoring program (see Figure 4-12). The groundwater extraction systems would be shut down during the monitoring events. The groundwater samples would be analyzed for VOCs, SVOCs, and PAHs. The field water quality parameters included in Alternative OSAGP2 would also be collected during each sampling event. Groundwater analytical data would be reviewed periodically to evaluate the effectiveness of the groundwater extraction systems. If the results of the monitoring show that the groundwater extraction system is not effective at reaching the groundwater PRGs, then the system would be shut down and a remedy similar to Alternative OSAGP2 (institutional controls, natural attenuation, and monitoring) would be implemented. However, for this alternative it was assumed that the remedy would not change and that the On-Site Southern Area Plume system would be operational for 11 years.

4.3.3.4 Alternative OSAGP4: Land Use Controls/Deed Notifications, In-Situ Biological Treatment (Biobarrier with HRC®), Natural Attenuation, and Monitoring

Alternative OSAGP4 was developed as a passive insitu bioremediation alternative. This alternative consists of implementing land use controls/deed notifications at Sites 6A and 10B, creating and maintaining an HRC® barrier to biologically treat COCs prior to off-site migration, and conducting groundwater monitoring. Calculations for this alternative are presented in Appendix B.

Land Use Controls/deed notifications would be implemented for the On-Site Southern Area Plume similar to those implemented for Alternative OSAGP2 to minimize risks to human health and the environment.

Groundwater treatment systems can be developed for source area treatment, downgradient plume containment, and a combination of both. This alternative was developed to contain the plume and prevent off-site migration. Based on previous sample results, chlorinated solvents are the primary COCs in the On-Site Southern Area Plume that would require treatment. HRC® would be the most effective additive for treatment of these COCs. Creation of a biological barrier with HRC® is generally most effective if used to address dissolved contaminants in the aquifer after the source of contamination has been addressed. It was assumed for this alternative that all sources of contamination to groundwater (soils/free product) would be remediated. A pilot study would be conducted to determine the effectiveness of biological stimulation prior to full implementation of the remedial alternative.

A single treatment barrier using HRC® would be completed for the On-Site Southern Area Plume along the property boundary (see Figure 4-13). The HRC® would be injected in two rows to create the barrier along the property boundary. Calculations indicate that approximately 122,000 pounds of HRC® would need to be injected through 445 injection points (9-foot centers) to address the On-Site Southern Area Plume. The HRC® would be injected into the upper 30 feet of the overburden aquifer using DPT. It was estimated that the HRC® barrier would be effective at treating the chlorinated solvents for 1 year. Assuming the COC concentrations in the plume would decrease below PRGs within 11 years, the barrier would need to be maintained for this duration. Therefore the HRC® would need to be injected 11 times.

Groundwater monitoring would be conducted to determine the effectiveness of the HRC® barrier. Approximately ten new monitoring wells (5 upgradient and 5 downgradient) would be installed for the monitoring program (see Figure 2-12). The analytical program for monitoring would be similar to the one in Alternative OSAGP2. Groundwater sampling would be conducted quarterly for the first year of the alternative to provide baseline information and then annually for the next 10 years while the barrier is in place. This sampling would be performed in accordance with State and federal regulations. A re-evaluation of the site would be performed after 5 years to determine if any changes to the remedy or controls would be required.

TABLE 4-1

SCREENING OF TECHNOLOGIES AND PROCESS OPTIONS FOR SOIL
SITE 6A AND SITE 10B
NWIRP CALVERTON, NEW YORK

General Action	Technology	Process Options	Description	General Screening	
No Action	No Action	No Action	No activities conducted at site to address contamination.	Required by law. Retain for baseline comparison.	*
Limited Action	Institutional Controls	Passive Controls: Deed Restrictions and Land Use Controls	Administrative action used to restrict soil use and future site activities.	Land use controls would be applicable while the Navy retains ownership of the property, and deed notification would be used in the event that the Navy sells the property. Both controls are viable, in combination with other technologies, because contaminated soil and material may remain in place. Both controls would restrict excavation and reuse of contaminated soil.	*
		Active Controls: Physical Barriers/Security Guards	Fencing, markers, and warning signs to restrict access.	Sites are currently located within a restricted area. Contaminated soil is not available for direct contact at either site. These controls may not be effective if site conditions change.	x
	Monitoring	Soil Sampling	Collection and analysis of soil samples to assess contaminant trends and the effectiveness of remediation.	Soil sampling can be conducted to assess contaminant trends and the effectiveness of remediation at the sites.	*
	Natural Attenuation	Natural Attenuation	Monitoring of soil concentrations, soil vapor concentrations, and/or microbiological parameters to assess contaminant reduction rate due to natural attenuation processes.	Many of the soil contaminants are amenable to natural attenuation. If appropriate conditions exist, contaminants would degrade through aerobic (petroleum) and anerobic (chlorinated solvents) processes. However, the presence of free product and significant soil concentrations would slow natural attenuation processes and would result in a continuing source of contamination to groundwater. Clean-up times would be extended for decades. PCBs would not be addressed.	x

TABLE 4-1

SCREENING OF TECHNOLOGIES AND PROCESS OPTIONS FOR SOIL
SITE 6A AND SITE 10B
NWIRP CALVERTON, NEW YORK

General Action	Technology	Process Options	Description	General Screening	
Containment	Capping	Capping	Use of impermeable or semi-permeable materials (e.g., soil, clay, synthetic membrane, or asphalt) to prevent exposure to contamination and/or to reduce the vertical migration of contaminants to groundwater.	An impermeable cap would be successful in preventing exposure to contaminated material and in reducing infiltration of precipitation but may restrict future site uses. The cap would also prevent contact of the contaminants with air and moisture, which would limit natural biological degradation.	x
	Cover	Soil Cover	Use of permeable material (e.g., soil) to prevent exposure to contamination.	A permeable cover would prevent exposure to contaminated materials but would not prevent infiltration of precipitation or contaminant migration to groundwater. The permeable cover may reduce transport of air and moisture to the subsurface.	x
Removal	Bulk Excavation	Bulk Excavation	Mechanical removal of solid materials using construction equipment.	Excavation would be effective at removing contamination. Excavation to less than 7 feet at Site 6A and less than 10 feet at Site 10B should address most of the contaminated soil. Some de-watering may be required. This alternative will be retained as a comparison to other alternatives.	*

TABLE 4-1

SCREENING OF TECHNOLOGIES AND PROCESS OPTIONS FOR SOIL
SITE 6A AND SITE 10B
NWIRP CALVERTON, NEW YORK

General Action	Technology	Process Options	Description	General Screening	
Disposal	Landfilling	Hazardous or Nonhazardous Waste Landfilling	Disposal of excavated material in an off-site landfill.	Off-site waste landfills may be utilized as a primary technology for disposal of contaminated material. Some of the contaminated soil from Site 6A is expected to be hazardous based on free product analyses, and the material from Site 10B is expected to be nonhazardous. As a secondary technology, off-site waste landfills (hazardous/nonhazardous) may be used for disposal of concentrated residuals from soil or waste treatment. On-site landfilling was eliminated because of reuse concerns.	*
	Recycling and Salvage	Recycling and Salvage	Recycling of contaminated soil instead of disposal.	The Site 10B soil, which is contaminated with petroleum products, could be recycled at asphalt batching plants, etc. Some of the soil at Site 6A would not be able to be recycled because of the high concentrations of chlorinated solvents and PCBs in the soil/free product.	*
	Consolidation	Consolidation	Relocation of untreated soil on site.	Contaminated and uncontaminated soil will be segregated and consolidated. Uncontaminated soil can be used as backfill. Consolidation is being considered as a secondary technology.	**
	Beneficial Reuse	Beneficial Reuse as Fill Material	On-site reuse of uncontaminated or treated soil.	Beneficial reuse as fill material for returning treated material to the site as backfill material.	**

General Action	Technology	Process Options	Description	General Screening	
Ex-Situ Treatment	Fixation	Solidification	Immobilization of contaminants by mixing with cement, fly ash, kiln dust, etc.	Solidification is feasible for treatment of soil contaminated with inorganics. It is not well suited for organically contaminated soil.	x
	Physical	Soil Washing/Solvent Extraction	Separation of contaminants from a medium by contact with water or solvents with a high affinity for the COCs.	This option has been shown to be effective on solvent- and petroleum-contaminated soil. Additional cost of excavation would be significant. Soil pre-treatment may be required prior to off-site disposal if concentrations exceed land disposal requirements.	**
		Dewatering	Removal of free water from wastes using gravity (dewatering pad) or equipment such as a filter press.	Dewatering may be required prior to treatment, consolidation, or disposal of saturated contaminated soil.	**
	Thermal	Incineration	Volatilization and oxidation of organic compounds via conveyance through high temperature.	This option has been shown to be effective on solvent- and petroleum-contaminated soil. Additional cost of excavation would be significant. Soil pre-treatment may be required prior to off-site disposal if concentrations exceed land disposal requirements.	**
		Low-/High-Temperature Thermal Stripping	Use of low to high temperatures to volatilize organics. Offgas may require treatment to capture contaminants.	Low temperatures are effective on petroleum- and solvent-contaminated soil and high temperatures are effective on SVOCs and PCBs. Mobile units are available that could be brought to the site for on-site treatment. The cost of excavation would need to be considered.	*

SCREENING OF TECHNOLOGIES AND PROCESS OPTIONS FOR SOIL
SITE 6A AND SITE 10B
NWIRP CALVERTON, NEW YORK

General Action	Technology	Process Options	Description	General Screening	
Ex-Situ Treatment (cont'd)	Biological	Landfarming	Tilling of contaminated material in layers to remove VOCs and biodegrade organics.	Space is available at the facility; however, high concentrations of chlorinated solvents and PCBs may reduce the effectiveness and increase the time frame required for remediation. Additional cost of excavation would be significant.	x
		Bioslurry Treatment	Treatment of contaminated material in a slurry reactor under controlled conditions using natural or cultured microorganisms to biodegrade organics.	Use of aerobic and anaerobic reactors may be required to effectively treat the petroleum and chlorinated solvents in soil. High concentrations may reduce the effectiveness. Additional cost of excavation would be significant.	x
	Chemical	Oxidation	Use of strong oxidizers such as ozone, peroxide, chlorine, or permanganate to chemically oxidize materials.	Oxidation of petroleum-contaminated soil is more effective than oxidation of chlorinated solvent (chlorinated alkanes)-contaminated soil. Generally not cost effective for high concentrations because of amount of oxidizer required. Additional cost of excavation would be significant.	x
		Neutralization	Use of acids or bases to counteract excessive pH.	Neutralization should not be required based on site contaminants and conditions.	x
		Dechlorination	Use of chemicals to remove chlorine from chlorinated compounds.	This technology is effective for concentrated halogenated compounds (e.g., PCBs). PCBs are not present at high concentrations in site media.	x

TABLE 4-1

SCREENING OF TECHNOLOGIES AND PROCESS OPTIONS FOR SOIL
SITE 6A AND SITE 10B
NWIRP CALVERTON, NEW YORK

General Action	Technology	Process Options	Description	General Screening	
Ex-Situ Treatment (cont'd)	Solids Processing	Crushing and Grinding	Use of crushing and grinding to reduce the size of an object.	Crushing and grinding may be required for alternatives that involve excavation.	**
		Magnetic Separation	Separation of metal debris.	Magnetic separation would not be required for the soil media.	x
		Screening	Separation of material into fractions of the same size by passing through screens or mesh.	Screening may be warranted for alternatives that involve excavation.	**
In-Situ Treatment	Thermal	Vitrification	Melting of solids using electrically generated heat to glassify metals and combust organics.	The resulting solidified block covering a relatively large area would restrict the reuse of the sites. This technology would be cost-prohibitive compared to other technologies.	x
		Radio Frequency/ Electromagnetic (EM)/ Electrical Resistance Heating; Immersion Heaters	Use of radio waves, EM, electrical resistance, or immersion heaters to heat and volatilize contaminants.	This technology is applicable to organic contaminants such as those found at the site. This technology would be cost-prohibitive compared to other technologies.	x
		Steam Injection	Use of steam to heat and volatilize contaminants.	This technology is applicable to organic contaminants such as those found at the sites. Contamination is present in the vadose zone; however, water table fluctuations reduce the thickness of the vadose zone and the effectiveness of the technology. This technology would be cost-prohibitive compared to other technologies.	x

TABLE 4-1

SCREENING OF TECHNOLOGIES AND PROCESS OPTIONS FOR SOIL
SITE 6A AND SITE 10B
NWIRP CALVERTON, NEW YORK

General Action	Technology	Process Options	Description	General Screening	
In-Situ Treatment (cont'd)	Thermal (cont'd)	Hot Air Injection	Use of hot air to heat and volatilize contaminants.	This technology is applicable to organic contaminants such as those found at the site. Contamination is present in the vadose zone; however, water table fluctuations reduce the thickness of the vadose zone and the effectiveness of the technology. This technology would be cost-prohibitive compared to other technologies.	x
	Biological	Bioventing	Air is injected into the soil to provide oxygen to promote aerobic degradation.	Aerobic degradation would be effective for the petroleum contamination in the soil, but not the chlorinated solvents. Water table fluctuations reduce the thickness of the vadose zone and the effectiveness of the technology.	x
		Bioremediation	Air, moisture, and nutrients are introduced to soil to promote biodegradation by introduced or indigenous microorganisms.	This technology is applicable to the petroleum contamination in the soil, but not the chlorinated solvents, which degrade anerobically. Amendments can be distributed more effectively through the saturated zone. Water table fluctuations reduce the thickness of the vadose zone and the effectiveness of the technology.	x
	Chemical/ Physical	Soil Washing	Flushing of contaminants using injection and extraction well system and aboveground treatment system.	Contamination extends into water table making recovery of soil washing solution difficult. Potential for mixing washing solution and groundwater.	x

TABLE 4-1

SCREENING OF TECHNOLOGIES AND PROCESS OPTIONS FOR SOIL
SITE 6A AND SITE 10B
NWIRP CALVERTON, NEW YORK

General Action	Technology	Process Options	Description	General Screening	
In-Situ Treatment (cont'd)	Chemical	Chemical Oxidation	Oxidizing chemicals are injected into the saturated and unsaturated zones.	Oxidation of petroleum-contaminated soil is more effective than oxidation of chlorinated solvent (chlorinated alkanes)-contaminated soil. Most contamination is petroleum-related at Sites 6A and 10B. Oxidizing chemicals can be distributed more effectively through the saturated zone. Generally not cost effective for high concentrations because of amount of oxidizer required. Also not effective for PCB-contaminated soil.	*
	Physical	Vapor Extraction	Removal of VOCs using an induced vacuum created by an injection and extraction well system.	Alternative is not effective for low volatility contaminants (PAHs and PCBs) at the site. Water table fluctuations may minimize thickness of vadose zone, which would reduce the effectiveness of the technology.	*
		Fixation	Pressure injection of cement or other pozzolanic materials to form an impermeable solid.	Solidification is feasible for treatment of soil contaminated with inorganics. It is not well suited for organically contaminated soil. The solidified material covering a relatively large area would severely restrict reuse of the site.	x

* Potentially applicable as a primary technology.
** Potentially applicable as a secondary technology (e.g., handling of treatment residuals resulting from a primary technology). Discussed as appropriate under applicable alternatives.
x Not applicable as a primary technology.

TABLE 4-2

SUMMARY OF RETAINED PRIMARY SOIL TECHNOLOGIES AND PROCESS OPTIONS
SITE 6A AND SITE 10B
NWIRP CALVERTON, NEW YORK

General Action	Technology	Process Option
No Action	No Action	No Action
Institutional Controls	Institutional Controls	Land Use Controls/Deed Notifications
		Soil Monitoring
Removal	Bulk Excavation	Bulk Excavation
Disposal	Landfill	Hazardous and Nonhazardous Waste Landfills
	Recycling and Salvage	Recycling
Ex-Situ Treatment	Thermal	Low-/High-Temperature Thermal Stripping
In-Situ Treatment	Physical	Soil Vapor Extraction
	Chemical	Chemical Oxication

TABLE 4-3

SCREENING OF TECHNOLOGIES/PROCESS OPTIONS FOR GROUNDWATER
SITE 6A, SITE 10B, AND ON-SITE SOUTHERN AREA PLUME
NWIRP, CALVERTON, NEW YORK

General Action	Technology	Process Options	Description	General Screening	
No Action	No Action	No Action	No activities conducted at site to address contamination.	Required by law. Retain for baseline comparison to other technologies.	*
Limited Action	Monitoring	Groundwater Monitoring	Sampling and analysis to evaluate the migration of contaminants within or the potential contamination of groundwater.	Groundwater monitoring is viable for assessing the effectiveness of natural attenuation and containment or treatment measures, during and following remediation. Monitoring would be used in combination with other technologies if contaminated groundwater remains in place.	*
	Institutional Controls	Passive Controls: Deed Restrictions and Land Use Controls	Administrative action used to restrict groundwater use and future site activities.	Land use controls would be applicable while the Navy retains ownership of the property, and deed notifications would be used in the event that the Navy sells the property. Both controls are viable, in combination with other technologies, because contaminated groundwater/material may remain in place. Both controls would ban well installation and use of groundwater from existing wells.	*
		Active Controls: Physical Barriers/Security Guards	Fencing, markers, and warning signs to restrict site access.	Sites are currently located within a restricted area. Groundwater is not available for direct contact. These controls may not be effective if site conditions change.	x
		Alternative Water Supply	Replacement of contaminated groundwater source with alternative water supply for end user.	No current on-site groundwater users. An alternative water supply was provided for the only downgradient off-site groundwater user. It is unlikely that another water supply will need to be provided because of the lack of additional groundwater users.	*

TABLE 4-3

SCREENING OF TECHNOLOGIES/PROCESS OPTIONS FOR GROUNDWATER
SITE 6A, SITE 10B, AND ON-SITE SOUTHERN AREA PLUME
NWIRP, CALVERTON, NEW YORK

General Action	Technology	Process Options	Description	General Screening	
Limited Action (Continued)	Natural Attenuation	Natural Attenuation	Monitoring groundwater to assess the natural processes that affect the rate of migration and the concentrations of contaminants.	Many of the groundwater contaminants (chlorinated solvents and petroleum contaminants) are amenable to natural attenuation. Use in combination with other technologies if groundwater remains in place. Most effective if contaminant source is addressed first.	*
Containment	Capping	Capping	Use of impermeable or semi-permeable materials (e.g., soil, clay, synthetic membrane, asphalt) to prevent exposure to contamination and/or to reduce the vertical migration of contaminants to groundwater.	Capping will not address groundwater contamination. A majority of the contaminants are already present in the groundwater and the soil at the water table.	x
	Cut-Off Barriers	Slurry Wall	Clay wall used to restrict horizontal migration of contaminants.	This technology may be appropriate for the source areas at Sites 6A and 10B because a clay confining unit is present at approximately 60 feet below the ground surface into which the barrier can be tied. The concentrations of chlorinated hydrocarbons would need to be considered so that the effectiveness of the slurry wall was not compromised. The process is capital cost intensive, and it does not treat groundwater contamination or reduce the clean-up time.	x

TABLE 4-3

SCREENING OF TECHNOLOGIES/PROCESS OPTIONS FOR GROUNDWATER
SITE 6A, SITE 10B, AND ON-SITE SOUTHERN AREA PLUME
NWIRP, CALVERTON, NEW YORK

General Action	Technology	Process Options	Description	General Screening	
Containment (Continued)	Cut-Off-Barriers (Continued)	Sheet Piling	Sheet made of wood, pre-cast concrete, or steel used as a retaining wall to restrict horizontal migration of contaminants.	This technology may be appropriate for the source areas at Sites 6A and 10B. A clay confining unit is present at approximately 60 feet below the ground surface into which the barrier can be tied. The process is capital cost intensive, and it does not treat groundwater contamination or reduce the clean-up time.	x
		Bank Revetment	Riprap, piling, etc. used to protect and stabilize slopes of river bank.	Slopes requiring stabilization are not present at the site.	x
	Horizontal Barriers	Jet Grouting Curtain	Use of pressure-injected cement to restrict vertical migration of contaminants to groundwater.	A clay confining unit is present at approximately 60 feet below the ground surface. Vertical migration of contamination was not identified as a significant concern.	x
Removal	Extraction	Extraction Wells	Discrete pumping wells strategically placed to remove contaminants from the entire plume.	Contaminated groundwater in or near source areas would be extracted via pumping wells and treated prior to discharge.	*
		Collection Trench	A permeable trench used to intercept and collect groundwater.	An effective permeable trench could probably be installed at the site because the aquifer is shallow and significant contamination is present in the upper portions of the aquifer.	*
		Product Removal	Discrete extraction wells designed to recover either floating product or sinking product.	Free product recovery was conducted at Site 6A until 1997. No significant amounts of recoverable free product remain at Sites 6A or 10B. A variation of this option may be used as a secondary technology.	**

TABLE 4-3

SCREENING OF TECHNOLOGIES/PROCESS OPTIONS FOR GROUNDWATER
SITE 6A, SITE 10B, AND ON-SITE SOUTHERN AREA PLUME
NWIRP, CALVERTON, NEW YORK

General Action	Technology	Process Options	Description	General Screening	
Removal (Continued)	Enhanced Removal	Enhanced Removal	Blasting or hydrofracturing of bedrock to promote access to groundwater in bedrock fractures.	Enhanced removal is not necessary based on site geology. The aquifer is sufficiently permeable to extract groundwater via conventional means.	x
Disposal	Beneficial Reuse	Beneficial Reuse as Process Water/Potable Water	On-site reuse of groundwater from which the contaminants have been removed.	Beneficial reuse of treated effluent as process water/potable water is not warranted because there is no need for process water/potable water services at this time.	x
	Surface Discharge	Direct Discharge	Discharge of collected/treated water to local surface water.	Direct discharge of effluent is not a viable option. Flowing surface water bodies are not located in close proximity of the sites.	x
		Indirect Discharge	Discharge of collected/treated water to a publicly owned treatment works (POTW).	Indirect discharge (POTW) of effluent is not a viable option. A POTW is not available in the area.	x
		Off-Site Treatment Facility	Treatment and disposal of hazardous or nonhazardous materials at permitted off-site facilities.	Off-site treatment facility is not feasible because the volume of contaminated groundwater is too large to effectively transport and treat off site.	x
	Subsurface Discharge	Reinjection	Use of reinjection, spray irrigation, or infiltration to discharge collected/treated groundwater to the underground.	Reinjection of untreated effluent is not a viable option. Reinjection of treated effluent may be appropriate to discharge treated water and enhance contaminant removal. Injection wells, infiltration galleries, and spray irrigation are potential options. The shallow groundwater table may limit the use of injection wells and infiltration galleries. Spray irrigation requires relatively large areas. Also, spray irrigation cannot be operated during the winter because of freezing problems.	*

TABLE 4-3

SCREENING OF TECHNOLOGIES/PROCESS OPTIONS FOR GROUNDWATER
SITE 6A, SITE 10B, AND ON-SITE SOUTHERN AREA PLUME
NWIRP, CALVERTON, NEW YORK

General Action	Technology	Process Options	Description	General Screening	
Ex-Situ Treatment	Physical	Solvent Extraction	Separation of contaminants from a solution by contact with an immiscible liquid with a higher affinity for the contaminants of concern.	Solvent extraction is typically utilized for high concentration wastewater streams and is rarely utilized for groundwater remediation.	x
		Dewatering	Mechanical removal of free water from wastes using equipment such as a filter press or a vacuum filter.	Dewatering of sludges resulting from precipitation processes for metals removal may be required in combination with other technologies.	**
		Detonation	Detoxification of explosive waste by setting off a charge.	Detonation is not applicable because no wastes are explosive.	x
		Equalization	Dampening of flow and/or contaminant concentration variation in a large vessel to promote constant discharge rate and water quality.	Equalization is feasible at the front end of a groundwater treatment system for equalizing flow and contaminant concentrations. Would be used in combination with other technologies.	**
		Filtration	Separation of materials from water via entrapment in a bed or membrane separation.	Filtration may be required for suspended solids and particulate metals removal. Would be used in combination with other technologies.	**
		Flotation	Separation of oils and suspended solids less dense than water by flotation methods.	This process may be appropriate for any free product extracted from Sites 6A and 10B. Would be used in combination with other technologies.	**
		Reverse Osmosis/ Ultrafiltration	Use of high pressure and membranes to separate dissolved materials, including organics and inorganics, from water.	Reverse osmosis/ultrafiltration is effective for removal of dissolved contaminants. This technology is considered only when other feasible options are not available.	x
		Volatilization	Contact of contaminated water with air to remove volatile compounds. Air stripping method is typically employed.	Air stripping would be effective for removal of volatile contaminants from groundwater. The technology would not be as effective on SVOCs.	*

TABLE 4-3

SCREENING OF TECHNOLOGIES/PROCESS OPTIONS FOR GROUNDWATER
SITE 6A, SITE 10B, AND ON-SITE SOUTHERN AREA PLUME
NWIRP, CALVERTON, NEW YORK

General Action	Technology	Process Options	Description	General Screening	
Ex-Situ Treatment (Continued)	Physical (Continued)	Gravity Settling/ Clarification	Flow of water through a quiescent tank to allow gravity settling of solids.	If sufficient suspended solids are present in the groundwater, then this technology will be considered as a secondary technology.	**
		Adsorption	Adsorption of contaminants onto activated carbon, resins, or activated alumina.	Adsorption may be considered for removal of VOCs and SVOCs from groundwater as a secondary technology.	**
		Evaporation	Change from the liquid to the gaseous state at a temperature below the boiling point.	Evaporation is typically utilized for high concentration wastewater streams and is rarely utilized for groundwater remediation.	x
		Electrodialysis	Recovery of anions or cations using special membranes under the influence of an electrical current.	Electrodialysis is typically utilized for high concentration wastewater streams. This technology is considered only when other feasible options are not available.	x
	Biological	Aerobic/Anaerobic Biodegradation	Suspended growth or fixed film process employing aeration and biomass recycle or anaerobic biomass to decompose biodegradable organic components.	Aerobic biodegradation would be applicable for petroleum hydrocarbons. Anaerobic biodegradation would be effective for chlorinated solvents. However, the dissolved contaminant concentrations in Sites 6A and 10B groundwater are too low to allow this technology to be effective.	x
	Chemical	Ion Exchange	Process in which ions, held by electrostatic forces to charged functional groups on the ion exchange resin surface, are exchanged for ions of similar charge in a water stream.	Ion exchange is a well-established technology for removal of heavy metals and hazardous anions from dilute solutions. The reliability of ion exchange is affected by the presence of suspended solids, organics, and oxidants. This technology is considered only when other feasible options are not available.	x

General Action	Technology	Process Options	Description	General Screening	
Ex-Situ Treatment (Continued)	Chemical (Continued)	Electrolytic Recovery	Passage of an electric current through a solution with resultant ion recovery on positive and negative electrodes.	Electrolytic recovery is typically utilized for high concentration wastewater streams and is rarely utilized for groundwater remediation.	x
		Enhanced Oxidation	Use of strong oxidizers such as ultraviolet light, ozone, peroxide, chlorine, or permanganate to chemically oxidize materials. Oxidation may also be accomplished through the use of high temperatures, pressures, and air.	Enhanced oxidation would be effective for the destruction of petroleum hydrocarbons in the groundwater; however, it would be less effective on removal of other site organics [chlorinated solvents (alkanes)].	x
		Reduction	Use of strong reducers such as sulfur dioxide, sulfite, or ferrous iron to chemically reduce the oxidation state of materials.	Reduction would not be effective for the petroleum hydrocarbons, but it may be effective for chlorinated solvents, which degrade best under anaerobic conditions.	x
		Neutralization	Use of acids or bases to counteract excessive pH or to adjust pH to optimum for a given technology.	Neutralization may be required in conjunction with pretreatment requirements for a given technology.	**
		Dechlorination	Use of chemicals to remove chlorine from chlorinated compounds.	Dechlorination is typically utilized for high concentration wastewater streams and is rarely utilized for groundwater remediation.	x
		Flocculation/ Coagulation	Use of chemicals to neutralize surface charges and promote attraction of colloidal particles to facilitate settling.	Flocculation/coagulation may be warranted to improve suspended solids removal.	**
		Precipitation	Use of reagents to convert soluble materials into insoluble materials.	Precipitation may be warranted for dissolved metals removal.	**

TABLE 4-3

SCREENING OF TECHNOLOGIES/PROCESS OPTIONS FOR GROUNDWATER
SITE 6A, SITE 10B, AND ON-SITE SOUTHERN AREA PLUME
NWIRP, CALVERTON, NEW YORK

General Action	Technology	Process Options	Description	General Screening	
In-Situ Treatment	Physical	Air Sparging or Air Sparging/Vapor Extraction	Volatilization and enhancement of biodegradation of organic compounds by supply of air with or without capture and treatment of volatilized compounds.	Site contaminants are amenable to volatilization and/or biodegradation. May not be effective in areas with free product. Potential problems with vapor extraction due to shallow water table.	*
		Permeable Reactive Barriers or Biological Barriers	Use of permeable barrier that allows the passage of groundwater and reacts with contaminants.	Process could be effective on site contaminants. Difficult to implement because different barrier media would be required for the chlorinated solvents and petroleum hydrocarbons present in the groundwater.	x
	Biological – Biostimulation	Aerobic/Anaerobic	Enhancement of biodegradation of organics in an aerobic and/or anaerobic environment by injection of nutrients and ORC®/HRC® or by injection of Bimetallic Nanoscale Particles (BNP).	Aerobic biodegradation using ORC® would be effective on the petroleum hydrocarbons present in the groundwater, and anaerobic biodegradation using HRC® or BNP would be effective on the chlorinated solvents in the groundwater. Petroleum hydrocarbons may enhance effectiveness of HRC®.	*
	Biological - Bioaugmentation	Aerobic/Anaerobic	Enhancement of biodegradation of organics in an aerobic and/or anaerobic environment by injection of microbes, inoculum, and/or bacterium.	Aerobic/anaerobic biodegradation could be effective on the petroleum hydrocarbons and chlorinated solvents, respectively, in the groundwater. Process would not be effective as a primary technology, but it could be used to improve effectiveness of other biological treatment options (biostimulation).	x
	Biological	Aerobic Biodegradation (Bioventing)	Enhancement of in-place biodegradation by addition of nutrients and control of environment.	Removal of contaminants from groundwater is achieved by air stripping/bioventing of contaminants. Contaminants must be able amenable to volatilization or aerobic biodegradation. May not be effective on the	x

TABLE 4-3

SCREENING OF TECHNOLOGIES/PROCESS OPTIONS FOR GROUNDWATER
SITE 6A, SITE 10B, AND ON-SITE SOUTHERN AREA PLUME
NWIRP, CALVERTON, NEW YORK

General Action	Technology	Process Options	Description	General Screening	
				chlorinated solvents.	
In-Situ Treatment (Continued)	Thermal	Dynamic Underground Stripping/Electrical Resistive Heating/Thermal Conductive Heating	Steam injection/electrical current/conductive heating elements are used to create a high-temperature zone resulting in the vaporization of volatile compounds bound to soil and the movement of contaminants to an extraction well.	Other processes are more effective at removing or treating the site groundwater contaminants. The process has a relatively high cost.	x
	Chemical	Enhanced Oxidation	Chemical destruction of organic COCs through oxidation with hydrogen peroxide and ferrous iron (Fenton's Reagent) or potassium permanganate.	Significant amounts of dissolved contamination have not been detected in the source area. Remaining free product will be addressed with the soil. Process would be more effective on the petroleum hydrocarbons versus the chlorinated solvents.	x
		Precipitation	Adjustment of soil/groundwater chemistry to decrease the solubility of metals. Actions may include the additional of calcium hydroxide to increase the groundwater pH and/or oxygen to convert the metals to less soluble ions.	This process would not be effective for the primary site contaminants (petroleum hydrocarbons and chlorinated solvents).	x

* Potentially applicable as a primary technology.

** Potentially applicable as a secondary technology (i.e., handling of treatment residuals resulting from a primary technology). Discussed as appropriate under applicable alternatives.

x Not applicable as a primary technology.

TABLE 4-4

SUMMARY OF RETAINED PRIMARY GROUNDWATER TECHNOLOGIES AND PROCESS OPTIONS
SITE 6A, SITE 10B, AND ON-SITE SOUTHERN AREA PLUME
NWIRP, CALVERTON, NEW YORK

General Action	Technology	Process Option
No Action	No Action	No Action
Limited Action	Monitoring	Groundwater Monitoring
	Institutional Controls	Land Use Controls/Deed Restrictions/Alternative Water Supply
	Natural Attenuation	Natural Attenuation
Removal	Extraction	Extraction Wells
		Collection Trench
Disposal	Subsurface Discharge	Reinjection (infiltration gallery/spray irrigation)
Ex-Situ Treatment	Physical	Volatilization (Air Stripping)
In-Situ Treatment	Physical	Air Sparging/Vapor Extraction
	Biological - Biostimulation	Aerobic (ORC®)/Anaerobic (HRC®)

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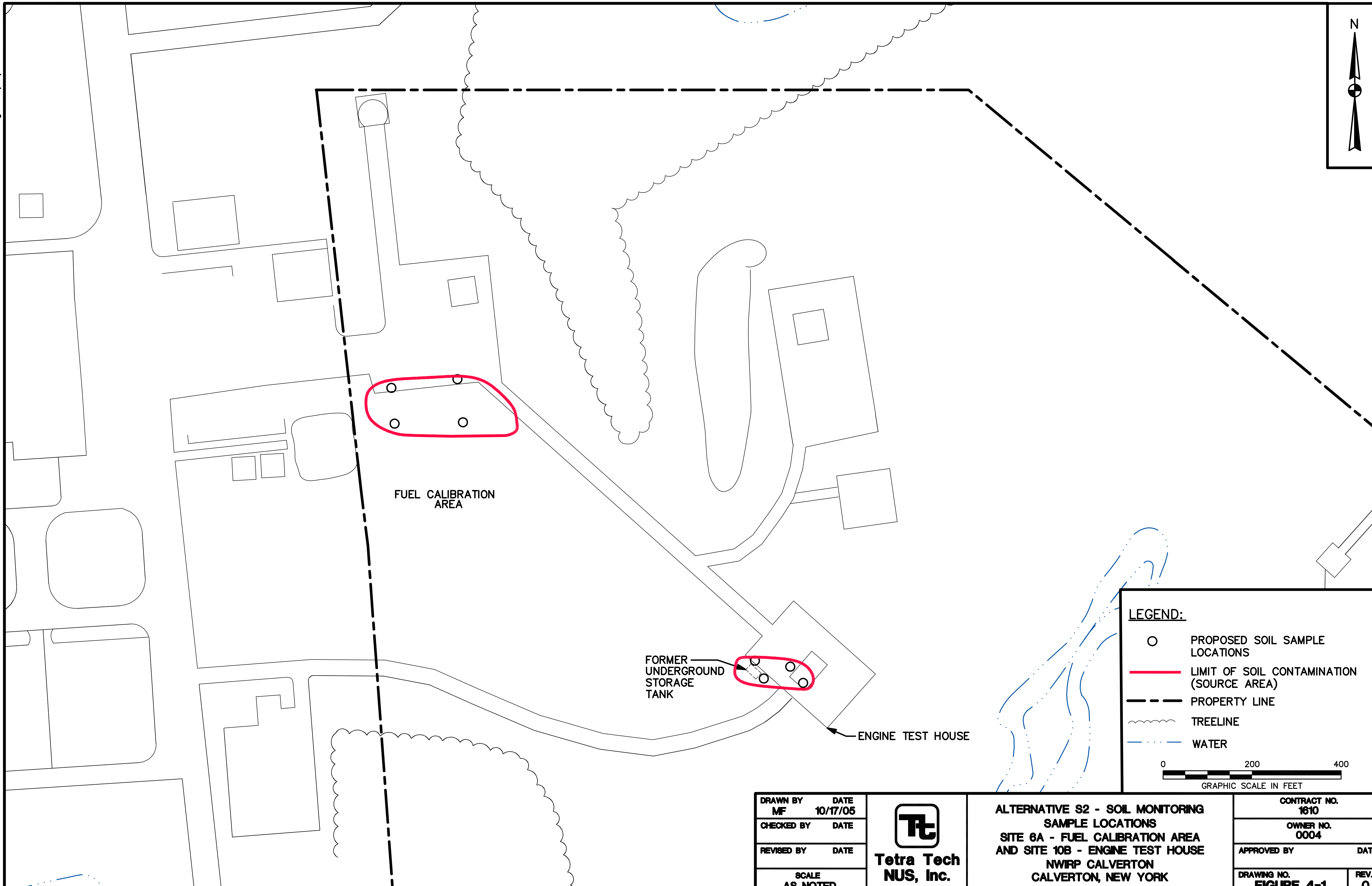

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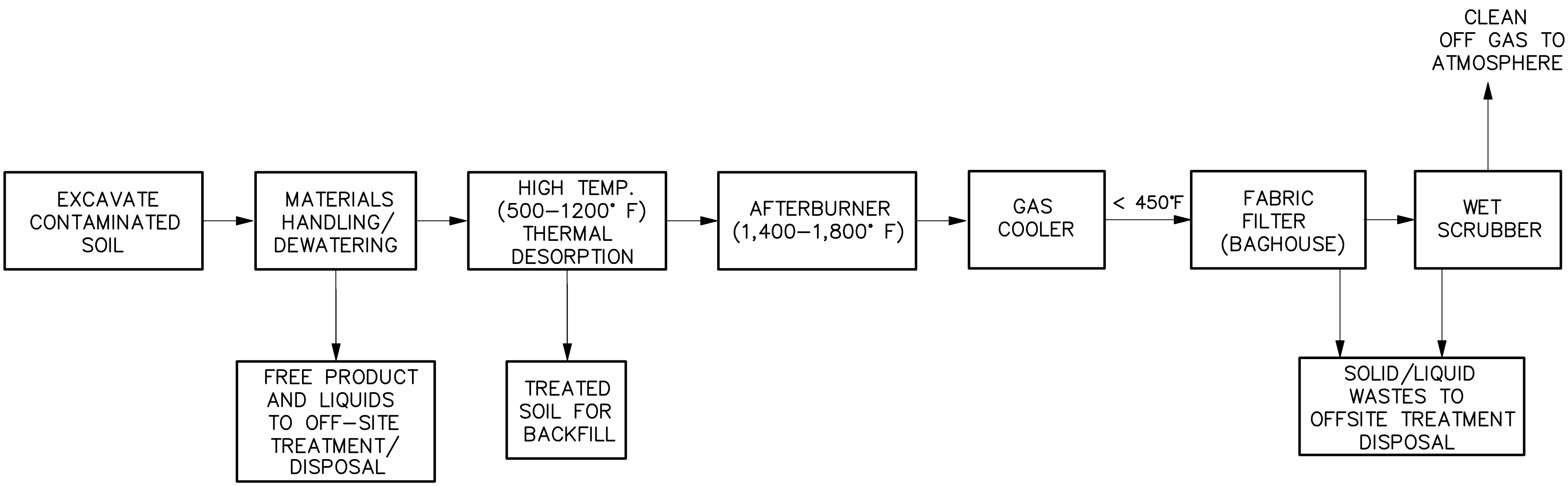

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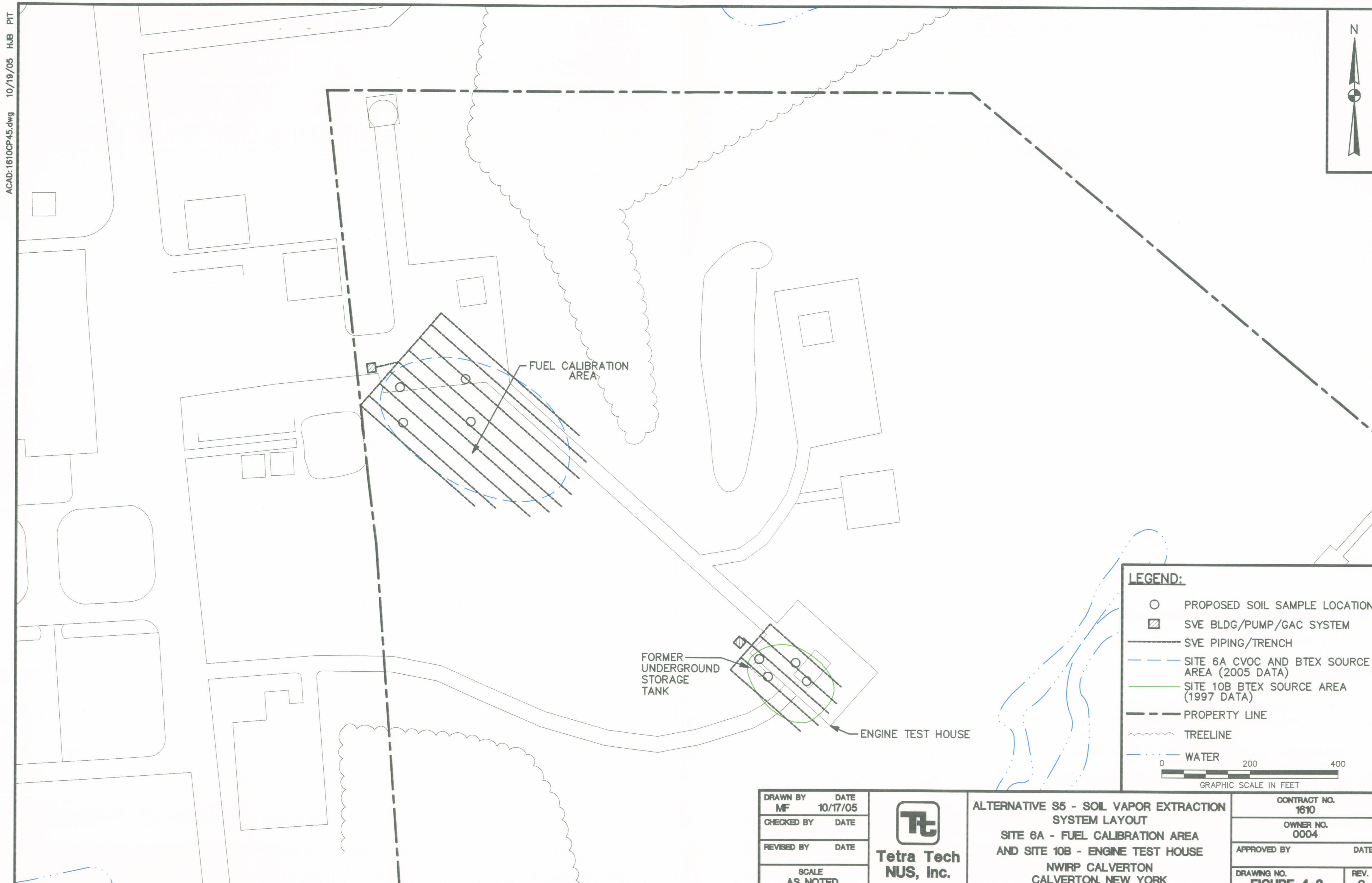
REVISED BY — DATE			APPROVED BY — DATE
SCALE AS NOTED			DRAWING NO. FIGURE 4-2 — REV. 0



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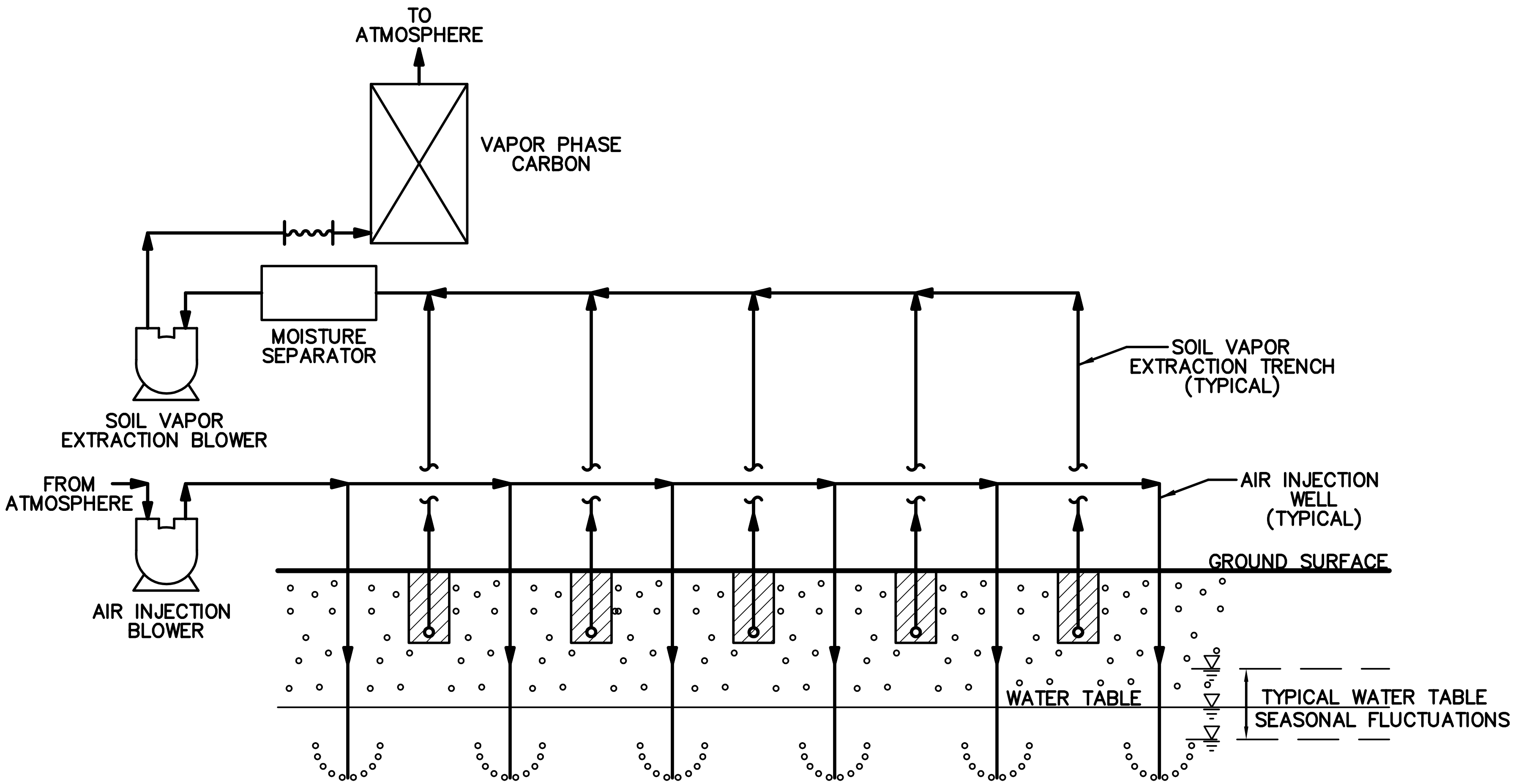

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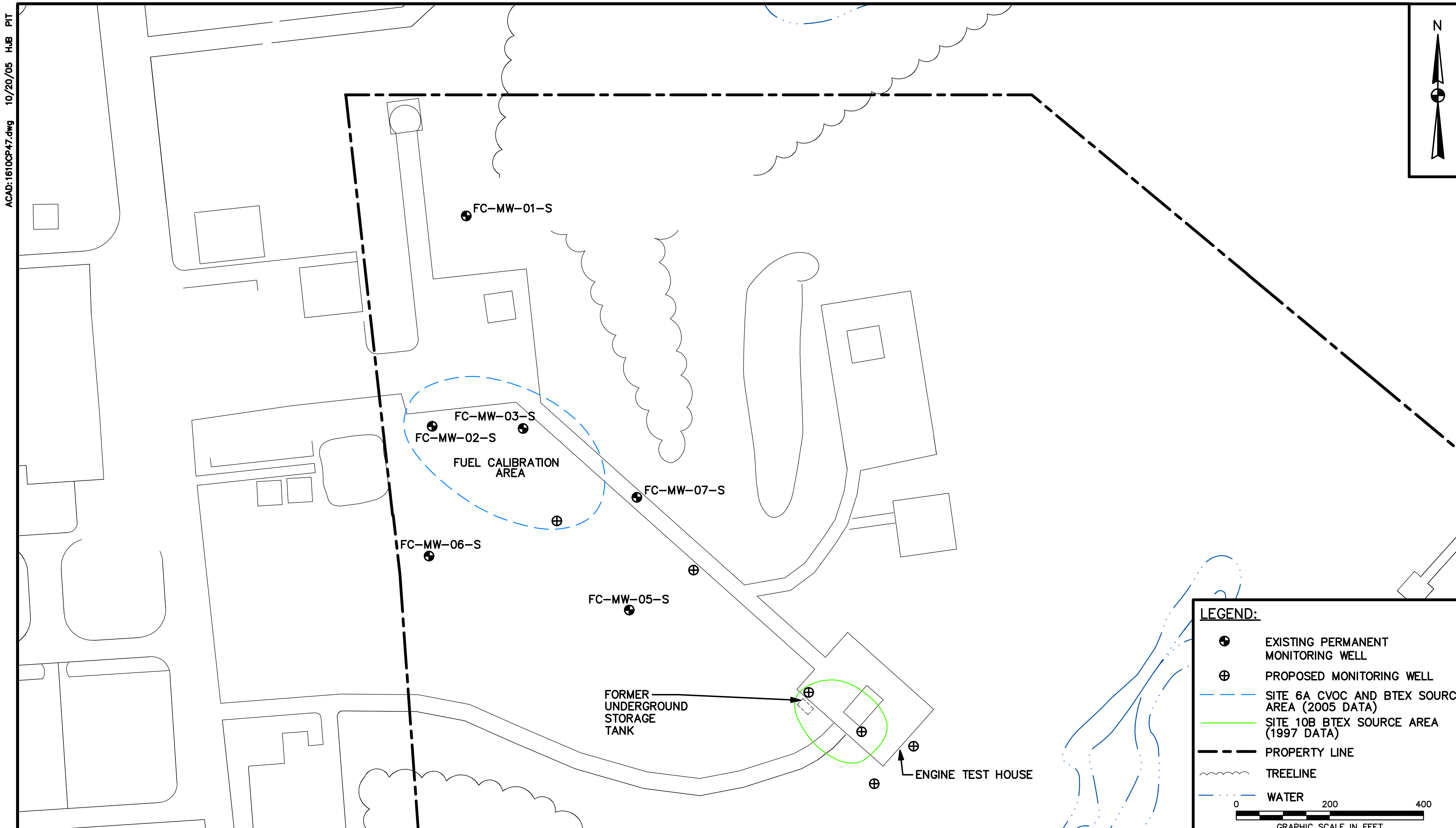
REVISED BY — DATE			APPROVED BY — DATE
SCALE AS NOTED			DRAWING NO. FIGURE 4-4 — REV. 0



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REVISED BY	DATE			APPROVED BY	DATE
SCALE AS NOTED				DRAWING NO. FIGURE 4-5	REV. 0

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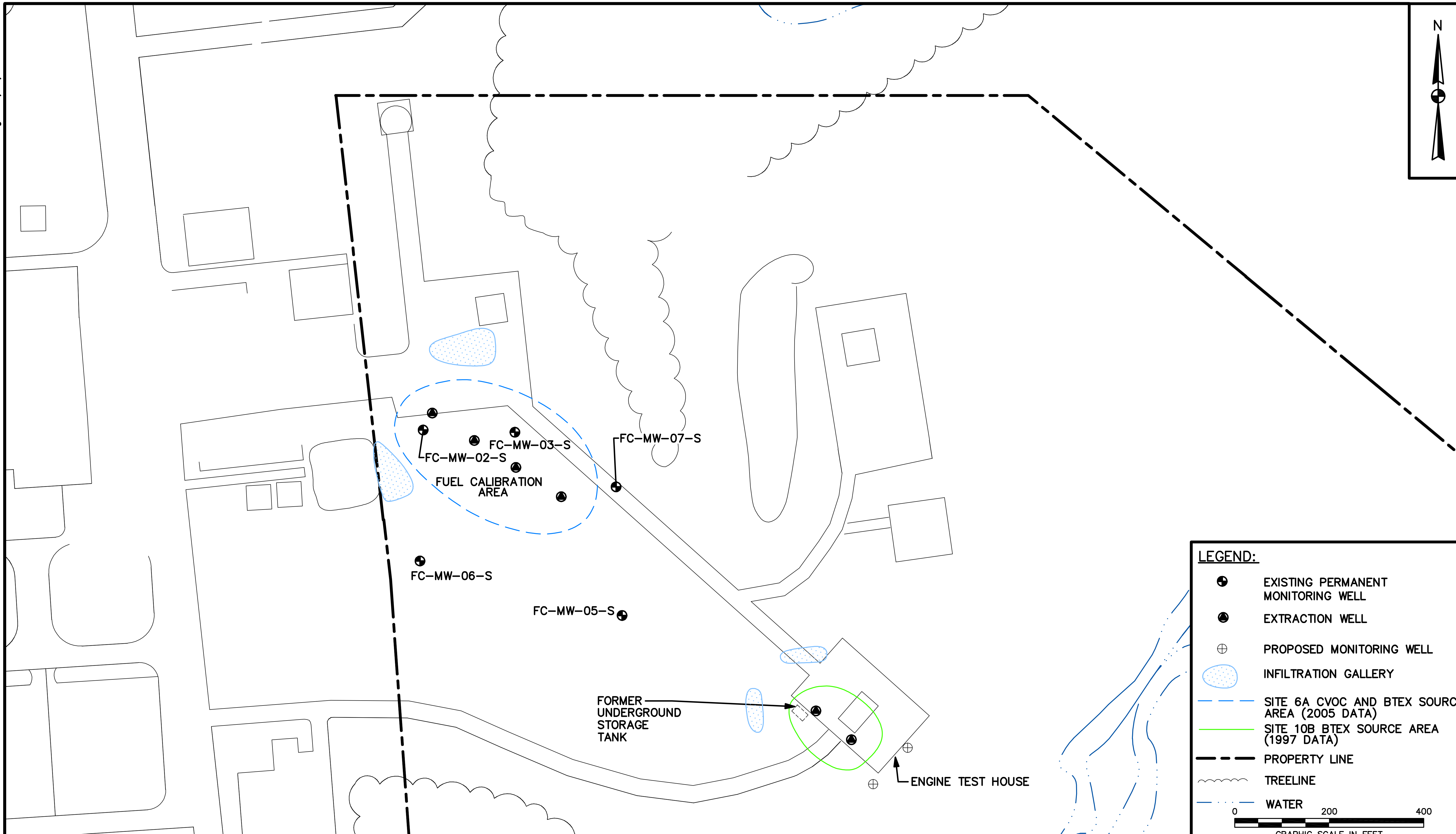

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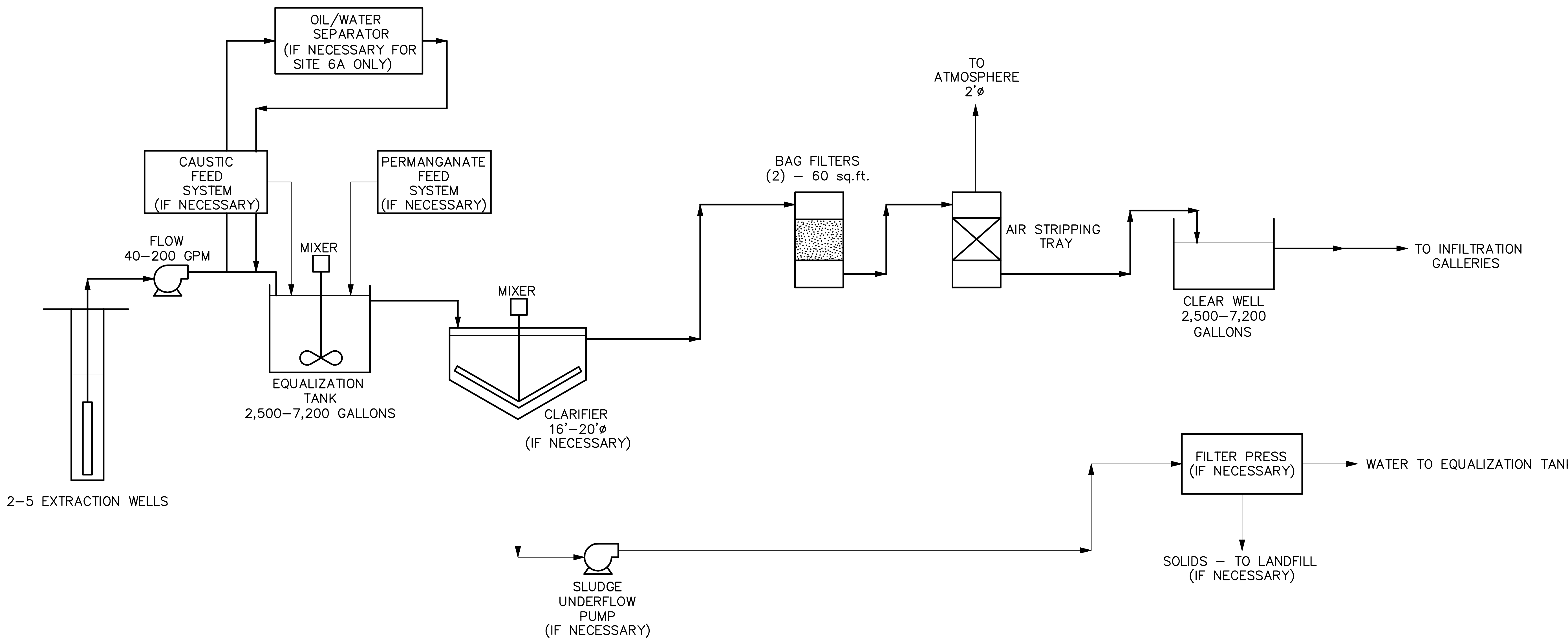
REVISED BY	DATE			APPROVED BY	DATE
SCALE AS NOTED				DRAWING NO. FIGURE 4-6	REV. 0



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REVISED BY — DATE			APPROVED BY — DATE
SCALE AS NOTED			DRAWING NO. FIGURE 4-7 — REV. 0

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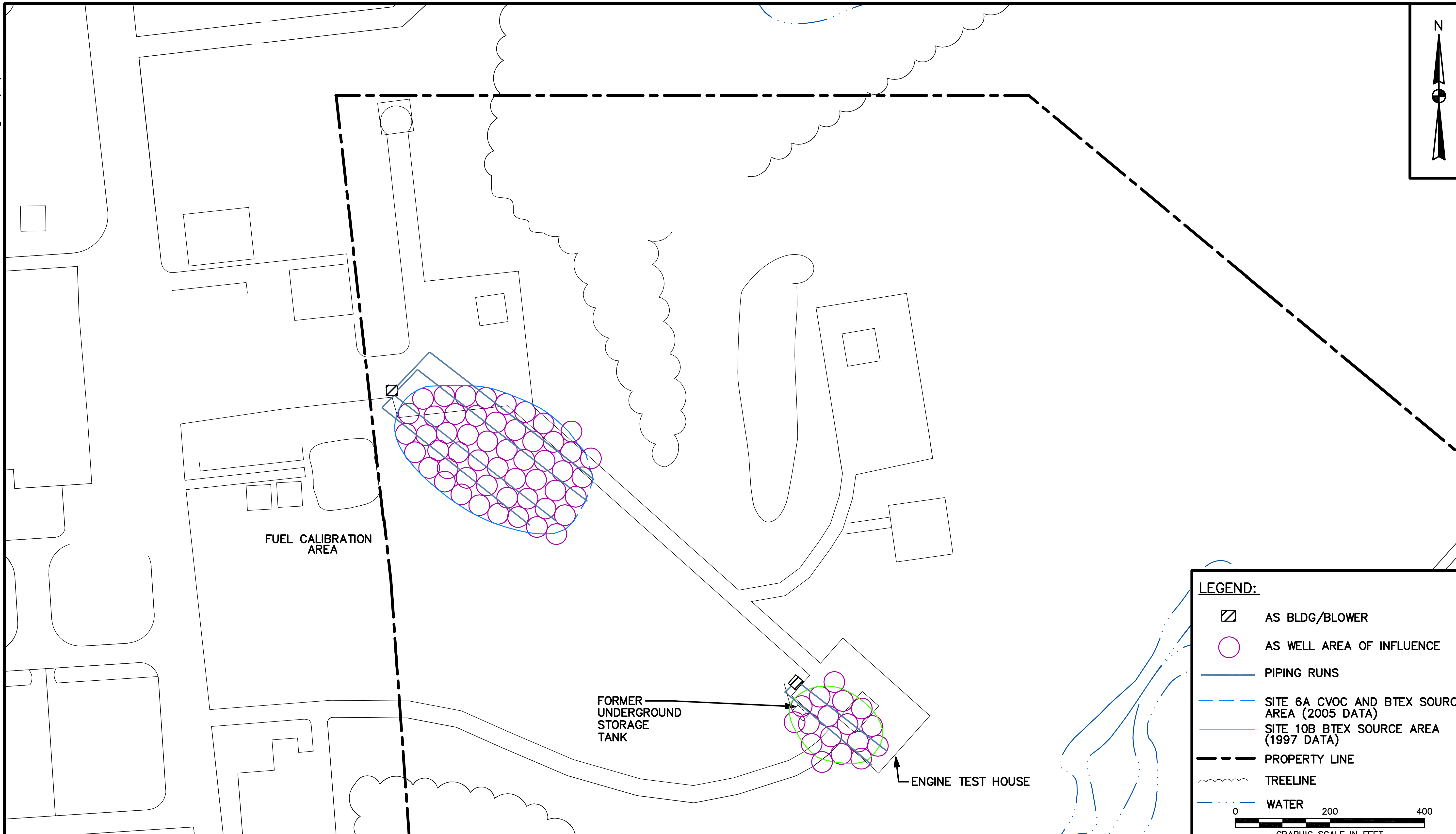

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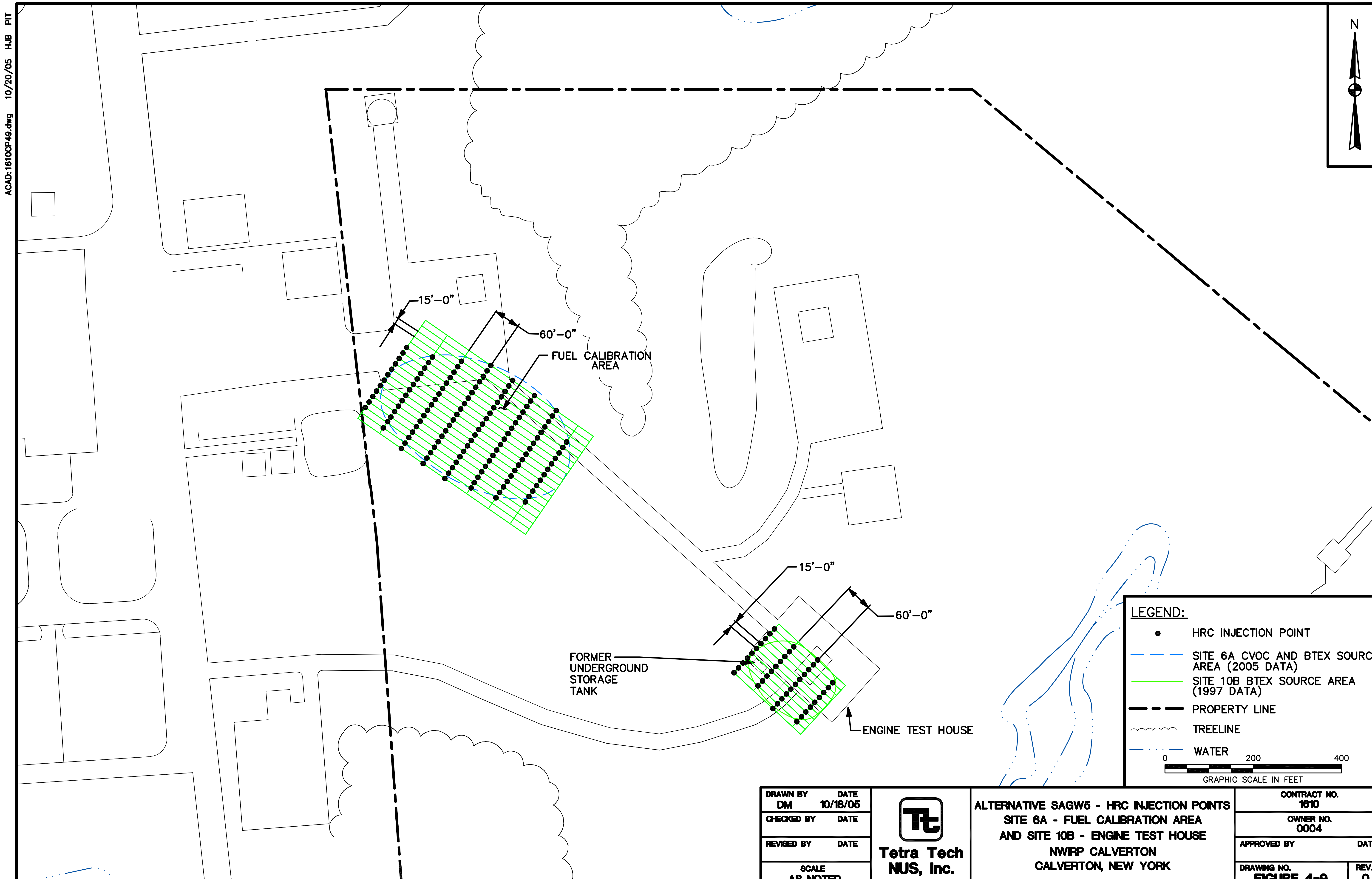
REVISED BY / DATE			APPROVED BY / DATE
SCALE AS NOTED			DRAWING NO. FIGURE 4-8 / REV. 0



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REVISED BY	DATE			APPROVED BY	DATE
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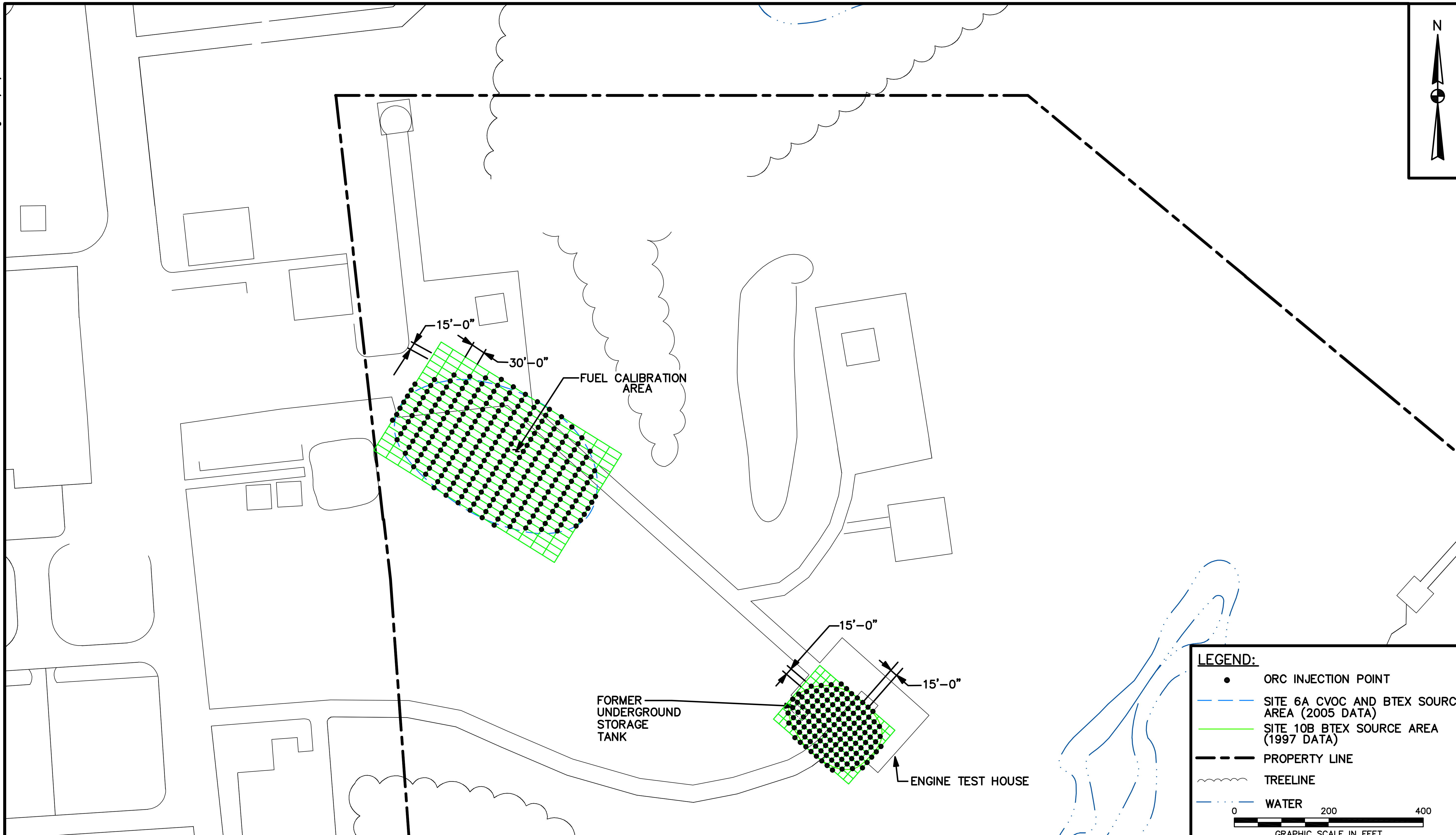

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DM	10/18/05	Tetra Tech NUS, Inc.		OWNER NO. 0004	
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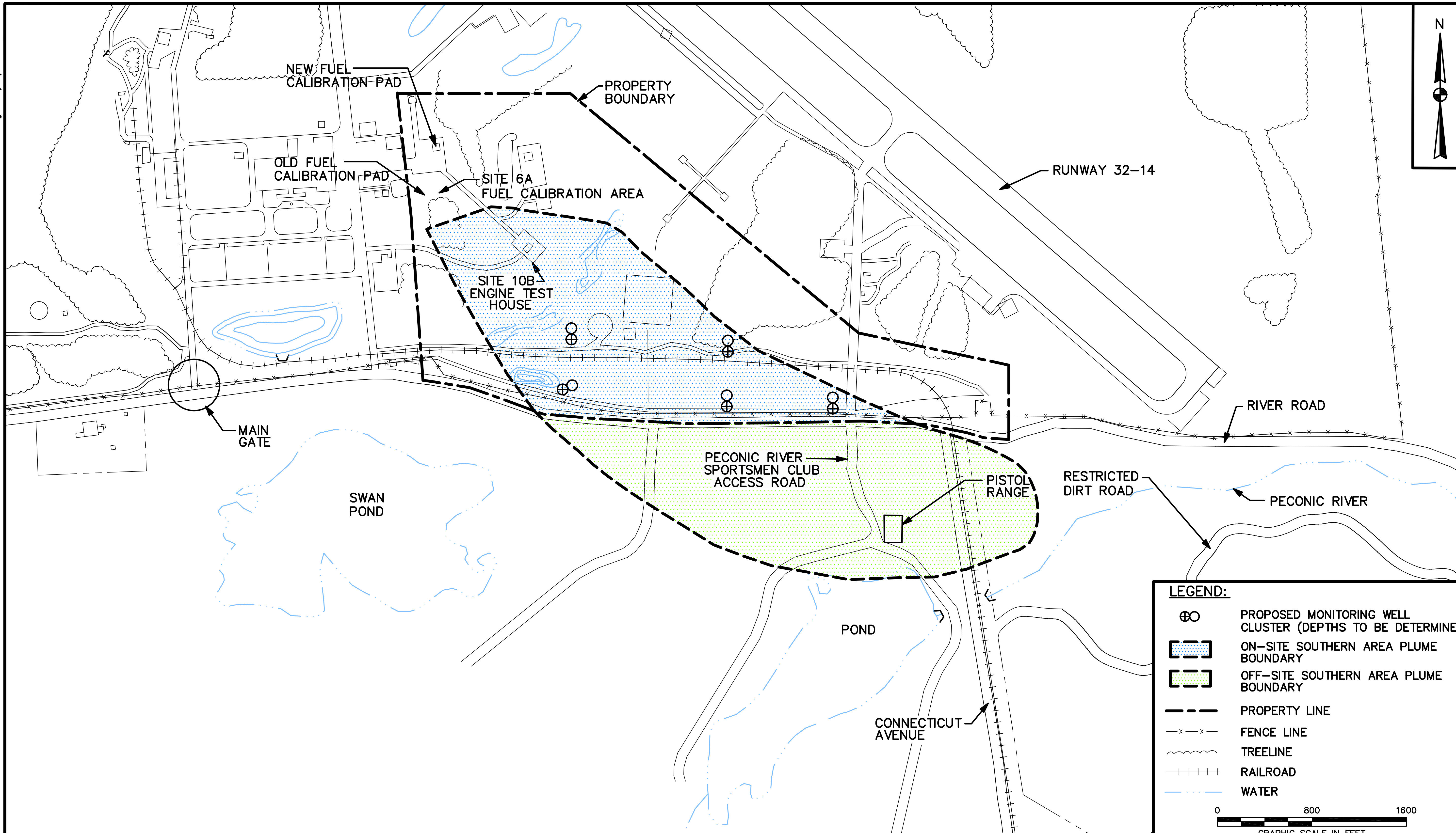

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REVISED BY	DATE			APPROVED BY / DATE
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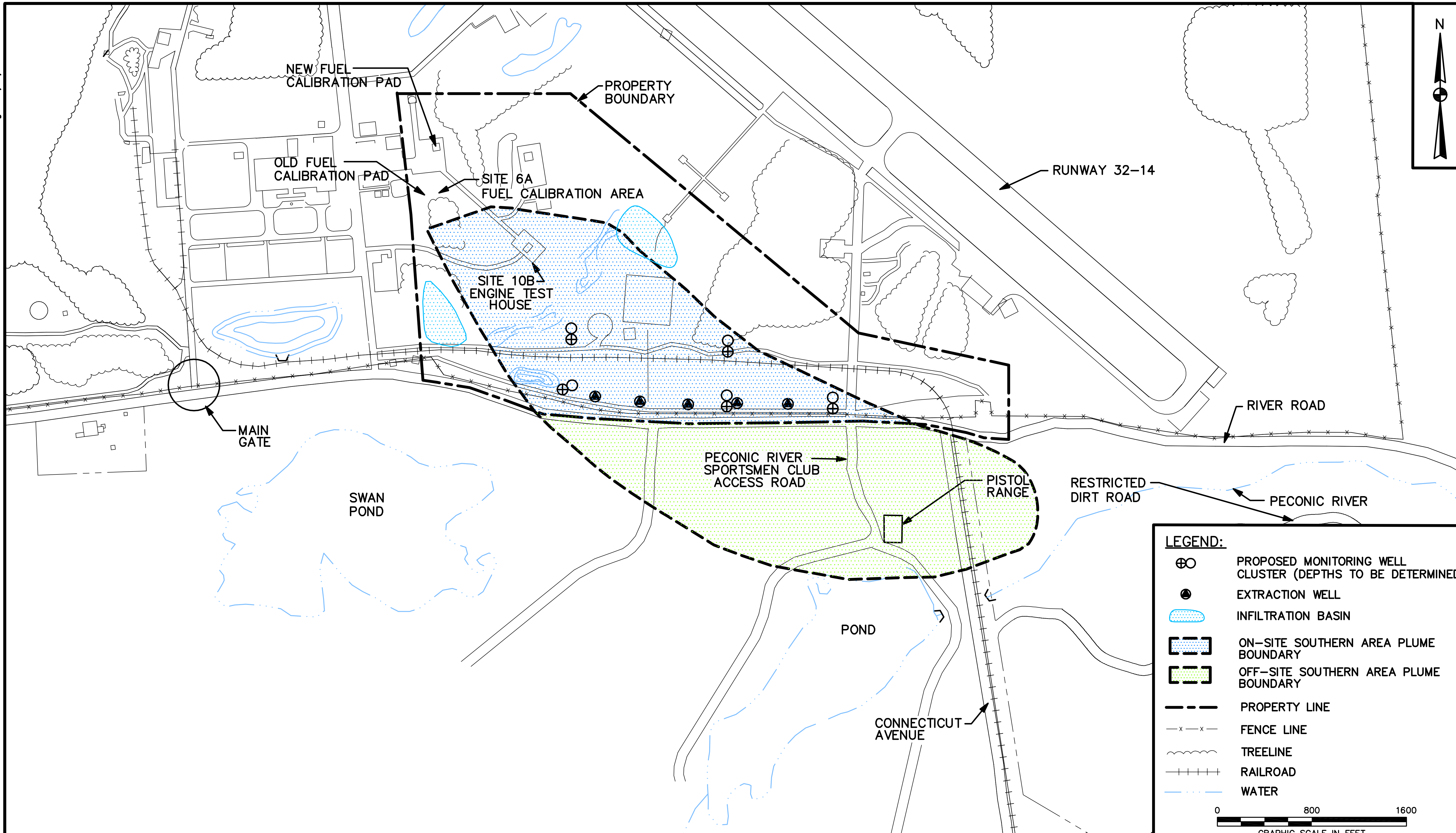

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Tetra Tech NUS, Inc.

ALTERNATIVE OSAGP3 - EXTRACTION WELLS, INFILTRATION GALLERIES, AND MONITORING WELLS ON-SITE SOUTHERN AREA PLUME NWIRP CALVERTON CALVERTON, NEW YORK

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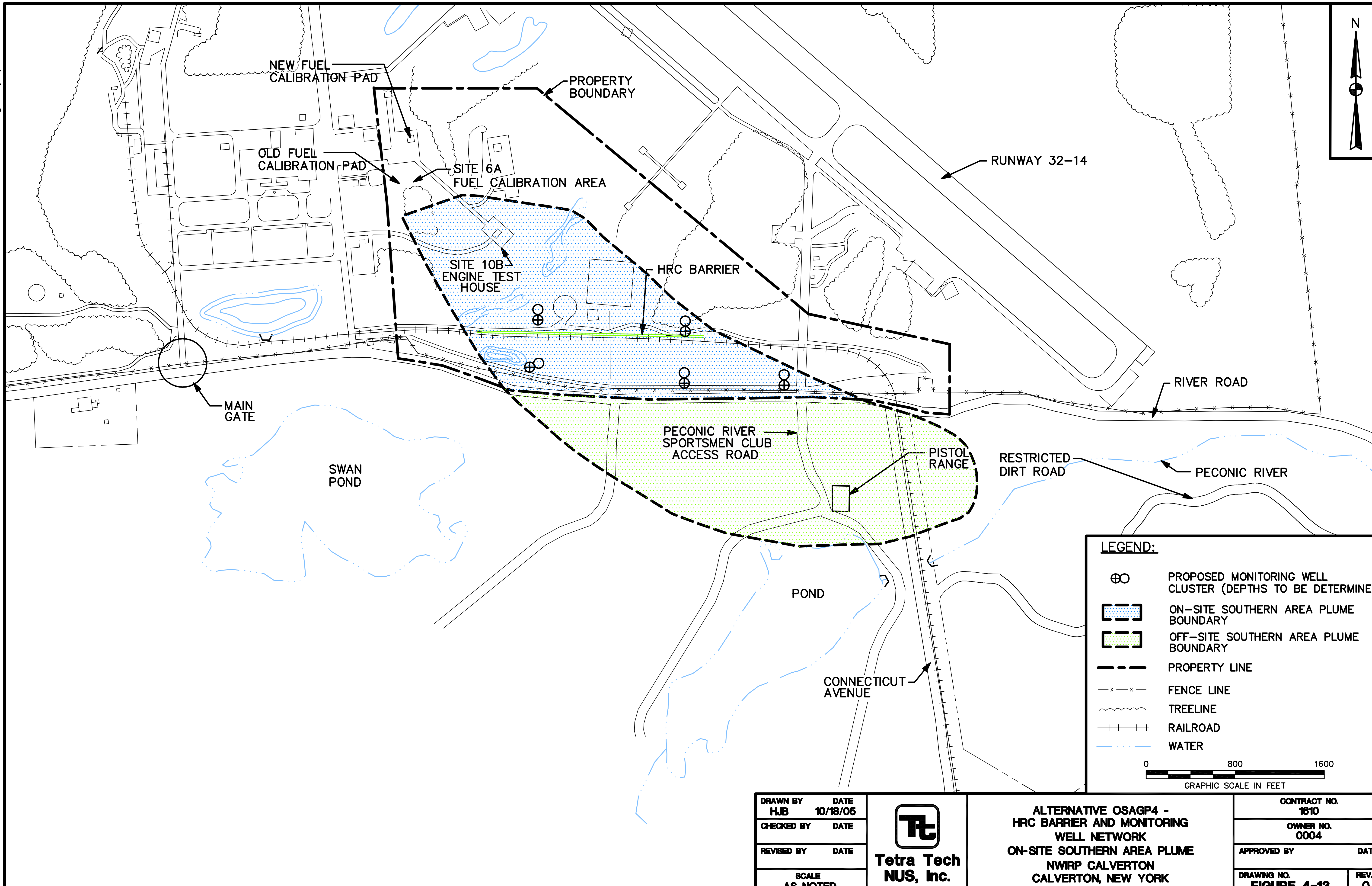

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5.0 EVALUATION OF THE CORRECTIVE MEASURES ALTERNATIVES

5.1 PROCEDURE FOR EVALUATING CORRECTIVE MEASURES ALTERNATIVES

The Corrective Measures Alternatives described in Section 4.3 are evaluated in this section. The alternatives are evaluated against technical, environmental, human health, and institutional criteria. Costs estimates are also provided. The format of the evaluation follows RCRA guidance; however, all of the CERCLA criteria used to evaluate remedial alternatives, except support agency and community acceptance, are addressed. Support agency and community acceptance are usually addressed after the preferred alternative has been identified.

5.2 EVALUATION OF SITE 6A AND SITE 10B SOIL CORRECTIVE MEASURES ALTERNATIVES

5.2.1 Alternative S1: No Action

Alternative S1 is considered primarily for comparison to the other corrective measures for Sites 6A and 10B soils.

5.2.1.1 Protection of Human Health and the Environment

This alternative is somewhat protective of human health. Although contaminants would remain in the soil and free product would be present for extended periods of time, some of the contaminants would slowly biodegrade and attenuate. Because of the depth of the contaminated soil (between 5 to 7 feet bgs at Site 6A and 4 and 10 feet bgs at Site 10B) and the concrete pads that cover portions of the contaminated soil at each site, the current risks to human health are low. However, under future potential scenarios, people could be directly exposed to the deep contaminated soils. In addition, contaminated soil and free product would continue to be a source of contamination to groundwater. Under these future scenarios, Alternative S1 would not be protective of human health.

Based on the type of contamination (fuels, solvents, and PCBs), depth of contamination (4 to 10 feet bgs), the distance from the sites to a surface water body (Peconic River), and natural attenuation factors, contamination from these sites would not be expected to pose a significant potential risk to ecological receptors.

5.2.1.2 Media Clean-Up Standards

Alternative S1 would not comply with soil criteria (PRGs) for the sites. The contaminated soil and free product would continue to pose a potential direct exposure risk if it is excavated in the future. It would also continue to be a contaminant migration problem to groundwater in the future.

5.2.1.3 Source Control

Alternative S1 involves no additional source control because no action would be performed at Sites 6A and 10B. The contaminated soil and free product at the sites would continue to act as sources of contamination to groundwater under this alternative. The fuel calibration and engine testing previously conducted at the sites are no longer conducted; therefore, no additional contaminant releases should occur at the sites.

5.2.1.4 Waste Management Standards

There are no actions to be implemented for Alternative S1; therefore, no waste would be generated.

5.2.1.5 Other Factors

Long-Term Reliability and Effectiveness

The future potential threat to human health would remain because there would be no access controls or removal or treatment of the contaminants. Organic contaminants (fuels and solvents) would decrease in concentration through natural attenuation processes but would remain in soil at Sites 6A and 10B at levels greater than the PRGs for an extended period and would continue to migrate to groundwater. The PCBs would not decrease appreciably through natural attenuation processes and would also remain at levels greater than PRGs. It is unlikely that PCBs would migrate to groundwater. Because no monitoring would be conducted, the long-term reliability and effectiveness of this alternative would not be known.

Reduction in Toxicity, Mobility, and Volume

Alternative S1 involves no reduction in toxicity, mobility, or volume of the contaminants at Sites 6A or 10B other than that which would result from natural processes. There would be no treatment processes employed; therefore, no materials would be treated or destroyed.

Short-Term Effectiveness

Alternative S1 involves no action; therefore, it would not pose any risks to on-site workers during implementation. No environmental impacts would be expected. This alternative would not achieve any of the CAOs.

Implementability

Because no actions would occur, this alternative is readily implementable. The technical feasibility criteria, including constructability, operability, and reliability, are not applicable.

Cost Analysis

There are no costs associated with the No Action alternative.

5.2.2 Alternative S2: Land Use Controls/Deed Notifications and Monitoring

This alternative involves limiting site access and use for contaminated soils at Sites 6A and 10B.

5.2.2.1 Protection of Human Health and the Environment

Alternative S2 would be protective of human health by limiting site access and land use within and around Sites 6A and 10B soils. Also, contaminant concentrations at the sites and potential for migration would be monitored. Existing contaminants at Sites 6A and 10B do not pose current or potential future risks to ecological receptors.

Because the surface soils at the sites do not represent an environmental risk, fencing is not required to limit non-intrusive activities. Restrictions would be placed to inform future workers of the contaminants in the subsurface soils and to prohibit the excavation and reuse of contaminated soil without proper management.

Soil sampling is included in this alternative to monitor the degradation of contaminants by natural processes. Periodic review of the site (every 5 years) would be necessary to ensure that contaminant concentrations were not increasing and to determine whether additional measures would be necessary to protect human health and the environment.

5.2.2.2 Media Clean-Up Standards

Alternative S2 would not comply with PRGs for soil in the short term (Site 6A and Site 10B) or long term (Site 6A only). The fuel- and solvent-related contaminants present at Sites 6A and 10B are biodegradable and/or subject to other natural attenuation processes; therefore, the PRGs for these COCs may ultimately be achieved. However, the length of time required and the potential for contamination to continue to leach to groundwater is uncertain. The PCBs in the soil at Site 6A would not decrease appreciably through natural attenuation processes and would remain at levels greater than PRGs into the foreseeable future. Land use controls/deed notifications would be used to prevent exposure to soil with contaminant concentrations greater than PRGs.

5.2.2.3 Source Control

Alternative S2 does not involve additional source control because only land use controls/deed notifications would be implemented. The contaminated soil and free product at the sites would continue to act as sources of contamination to groundwater under this alternative. The fuel calibration and engine testing previously conducted at the sites are no longer conducted; therefore, no additional contaminant releases should occur at the sites.

5.2.2.4 Waste Management Standards

Alternative S2 involves no removal of contaminated soil; therefore, this alternative would not generate any wastes. However, under this alternative incidental amounts of soil would be removed during soil monitoring activities, and this soil would be stored, transported, treated, and disposed in accordance with applicable State and federal regulations.

5.2.2.5 Other Factors

<u>Long-Term Reliability and Effectiveness</u>

Although no soil removal would occur in Alternative S2, the potential threats to human health would be minimized. This limited action alternative would use land use controls/deed notifications (transfer documents) to limit future use of the site and meet the CAO of preventing human exposure to contaminated soils with concentrations greater than PRGs

Land use controls/deed notifications have uncertain long-term effectiveness. The protection of the potential future construction worker would depend on effective administration and management of the controls. A re-evaluation of the site would be performed every 5 years to determine whether any changes to the controls would be required.

This alternative would not meet the CAO of preventing contaminant leaching to groundwater. Monitoring would be conducted to determine the rate at which soil contaminants are attenuating. The monitoring results would be used to determine the duration of the controls on the sites. In the event that contaminant concentrations increase, additional actions may be required.

Reduction in Toxicity, Mobility, and Volume

Alternative S2 would not result in reduction in toxicity, mobility, or volume through treatment of the hazardous substances at Sites 6A or 10B other than that which would result from natural processes.

Short-Term Effectiveness

Alternative S2 would involve soil monitoring, administration of land use controls/deed notifications, and potential restriction of residential land use. The short-term risks associated with these limited remedial activities would be minimal. Sampling personnel would wear the required personal protective equipment (PPE) and receive the appropriate health and safety training. There would be no potential risk to the community or environmental impacts upon implementation of land use controls/deed notifications.

Implementability

Alternative S2 is expected to be readily implementable because Sites 6A and 10B are currently located within a controlled facility where rules and local ordinances can be strictly enforced. Restrictions for future property use would involve legal assistance and regulatory approval. Provisions in the NWIRP Calverton transfer documents would be defined and enforced relatively easily because the site is located within a federal facility. Sampling and analysis are also readily implemented.

Cost Analysis

The following costs are estimated for Alternative S2:

Capital Costs:	$227,000
Operations and Maintenance (O&M) Costs:	$0
Monitoring Costs:	$1,000 per year (Annually)
	$36,000 per year (Every 5 years)
30-Year Present Worth:	$317,000

Detailed cost estimates are included in Appendix D. The present worth costs associated with Sites 6A and 10B for this alternative would be approximately equal at $158,500 per site.

5.2.3 Alternative S3: Excavation and Off-Site Treatment and Disposal

Contaminated soil at both Sites 6A and 10B would be excavated and subsequently transported off site for treatment and/or disposal as necessary. Prior to conducting the excavation alternative, a pre-design investigation would be conducted at both sites to confirm the extent of contamination and the COCs.

5.2.3.1 Protection of Human Health and the Environment

Alternative S3 would be protective of human health and the environment by excavating, treating (if necessary), and disposing of the contaminated soil/free product off site at an approved disposal facility. All of the contaminated soil above the water table with concentrations greater than PRGs would be addressed by this alternative. After excavation and disposal activities are completed, no soil monitoring or periodic reviews of the site (every 5 years) would be necessary to protect human health and the environment, and the remaining soil would not be a source of contamination to groundwater.

5.2.3.2 Media Clean-Up Standards

Alternative S3 would comply with soil PRGs. Soil with contaminant concentrations greater than PRGs would be excavated and subsequently transported off site for treatment and/or disposal as necessary. No institutional controls would be required to prevent exposure to soil in the future.

5.2.3.3 Source Control

Alternative S3 would directly address the existing contaminant sources at Sites 6A and 10B (contaminated soil/free product). The contaminated soil and free product at the sites would be addressed through excavation and off-site treatment and/or disposal. The fuel calibration and engine testing previously conducted at the sites are no longer conducted; therefore, no additional contaminant releases should occur at the sites.

5.2.3.4 Waste Management Standards

Wastes (concrete, contaminated soil and water, and free product) generated during implementation of this alternative would be tested to determine the required methods of off-site treatment and/or disposal. The wastes would be loaded into suitable containers and transferred to appropriate off-site treatment/disposal facilities. Waste identification, transportation, treatment, and disposal would be conducted in accordance with State and federal regulations.

Equipment used on site may come into contact with potentially hazardous chemicals (contaminated soil and free product). The equipment would be decontaminated prior to leaving the sites. Decontamination waste (soil or water) would be collected, sampled, and if required, properly treated and disposed.

5.2.3.5 Other Factors

Long-Term Reliability and Effectiveness

Alternative S3 would be very effective in the long term because the contaminated soil and free product would be removed from the sites and properly disposed. If the assumptions for this alternative are correct, this alternative would meet all of the CAOs. The effectiveness of the alternative would be increased if the alternative was implemented when the water table is at its seasonal low (late summer). However, if contaminated soil remains at the sites undetected below the water table and the water table fluctuates in the future and exposes the contaminated soil, this alternative may not be fully protective of human health and the environment.

Confirmation and waste disposal sampling and analysis would be conducted to determine the effectiveness of this alternative. No long-term monitoring would be performed for this alternative.

During excavation activities, PPE would be used and monitoring conducted to ensure that exposure of workers to potentially contaminated material is minimized.

Reduction in Toxicity, Mobility, and Volume

Alternative S3 would utilize off-site treatment as necessary to reduce the toxicity, mobility, and volume of the potential hazardous waste (soil and free product) generated during implementation of the alternative. Approximately 785 cubic yards of contaminated soil (25 percent of the petroleum-contaminated soil, 1,545 cy plus 15 cy of PCB-contaminated soil) and 860 gallons of free product (i.e., 10 percent of the estimated volume of free product in the contaminated soil at Sites 6A and 10B) would require off-site treatment/disposal. Limited on-site treatment of contaminated soil (i.e., dewatering to remove free product and liquids) would also be performed under this alternative. It was estimated that a similar volume of nonhazardous contaminated water (860 gallons) would be collected during dewatering activities and disposed off site without requiring treatment. The remaining nonhazardous waste (2,595 cubic yards of contaminated soil, 2,320 cy of adjacent soils, and 560 cubic yards of concrete) would be disposed off site without treatment to reduce the toxicity or volume of the waste. The mobility of contaminants in the nonhazardous contaminated soil would be addressed by containment (landfilling).

Short-Term Effectiveness

Alternative S3 would be effective in the short-term by following safe work practices. Excavation and off-site transportation of waste material is expected to take less than 6 months to complete. All of the free product and some of the contaminated soil (25 percent of the petroleum-contaminated soil plus 15 cy of the PCB-contaminated soil) are anticipated to be hazardous and would pose risks to site workers during on-site activities and to the community during transportion. The remaining waste (75 percent of the petroleum contaminated soil, 395 cy of PCB-contaminated soil, and all of the concrete and water) is expected to be nonhazardous and would pose lower risks to site workers and the community. Site workers would receive appropriate health and safety training and would wear the required PPE during the implementation of the alternative. Waste transportation, treatment, and disposal would be conducted in accordance with State and federal regulations to protect the community. Equipment would be decontaminated prior to leaving the sites.

Implementability

Alternative S3 is considered to be implementable. Contractors and equipment are readily available to conduct excavation and transportion activities. The excavation technology is well proven and established in the remediation and construction industries. Several treatment/disposal facilities are available for the nonhazardous waste, but only a limited number of facilities are available for the hazardous waste. Depending on the waste characterization results, some of the hazardous waste may need to be transported extensive distances for treatment/disposal. Confirmation and waste characterization sampling and analysis are also readily implementable.

Cost Analysis

The following costs are estimated for Alternative S3:

Capital Costs:	$3,710,000
O&M Costs:	$0
Monitoring Costs:	$0 per year
30-Year Present Worth:	$3,710,000

Detailed cost estimates are provided in Appendix D. The present worth costs associated with Sites 6A and 10B were estimated to be $2,873,000 and $837,000, respectively.

5.2.4 Alternative S4: Excavation, On-Site Treatment (Thermal), and On-Site Reuse

Contaminated soil from both Sites 6 and 10B would be excavated and then treated on site in a thermal treatment unit. Prior to conducting the excavation alternative, a pre-design investigation would be conducted at both sites to confirm the extent of contamination and the COCs

5.2.4.1 Protection of Human Health and the Environment

Alternative S4 would be protective of human health and the environment by excavating the contaminated soil at Sites 6A and 10B and treating it on site by thermal desorption to the required PRGs. Contaminated water and free product collected during soil dewatering would be disposed off site at an approved disposal facility. All of the contaminated soil above the water table with concentrations greater than PRGs would be addressed by this alternative. After excavation and disposal activities are completed, no soil monitoring or periodic reviews of the site (every 5 years) would be necessary to protect human health and the environment, and the remaining soil would not be a source of contamination to groundwater.

5.2.4.2 Media Clean-Up Standards

Alternative S4 would comply with soil PRGs. Soil with contaminant concentrations greater than PRGs would be excavated and subsequently treated on site in a high-temperature thermal desorption unit. Contaminated water and free product collected during soil dewatering would be disposed off site at an approved disposal facility. No institutional controls would be required to prevent exposure to soil in the future.

5.2.4.3 Source Control

Alternative S4 would directly address the existing contaminant sources at Sites 6A and 10B (contaminated soil/free product). The contaminated soil and free product trapped in the soil pore spaces would be addressed through excavation and on-site thermal treatment. Contaminated water and free product collected during soil dewatering would be disposed off site at an approved disposal facility. The fuel calibration and engine testing previously conducted at the sites are no longer conducted; therefore, no additional contaminant releases should occur at the sites.

5.2.4.4 Waste Management Standards

The contaminated soil excavated from both sites would be managed and treated on site. After the soil is treated to PRGs, it would be reused on site as backfill. Wastes generated during implementation of this alternative (concrete, contaminated water, free product, and residual waste from the treatment of the off gas) would be tested to determine the required methods of off-site treatment and/or disposal. The wastes would be loaded into suitable containers and transferred to appropriate off-site treatment/disposal facilities. Waste identification, transportation, treatment, and disposal would be conducted in accordance with State and federal regulations.

Equipment used on site may come into contact with potentially hazardous chemicals (contaminated soil and free product). The equipment would be decontaminated prior to leaving the sites. Decontamination waste (soil or water) would be collected, sampled, and if required, properly treated and disposed.

5.2.4.5 Other Factors

Long-Term Reliability and Effectiveness

Alternative S4 would be very effective in the long term because the contaminated soil would be treated and reused and the recovered free product would be properly treated/disposed. If the assumptions for this alternative are correct, this alternative would meet all of the CAOs. The effectiveness of the alternative would be increased if the alternative was implemented when the water table is at its seasonal low (late summer). However, if contaminated soil remains at the sites below the water table and the water table fluctuates in the future and exposes the contaminated soil, this alternative may not be fully protective of human health and the environment.

Confirmation and waste disposal sampling and analysis would be conducted to determine the effectiveness of this alternative. Confirmation samples would be collected to confirm the extent of excavation and also to confirm that the treatment process achieved the PRGs. No long-term monitoring would be performed for this alternative.

During excavation activities, PPE would be used and monitoring conducted to ensure that exposure of the workers to potentially contaminated material is minimized.

Reduction in Toxicity, Mobility, and Volume

Alternative S4 would primarily utilize on-site high-temperature thermal treatment to reduce the toxicity, mobility, and volume of the contaminants in Site 6A and 10B soil. Assuming standard destruction efficiencies (95 percent) are achieved, approximately 43,510 pounds of petroleum hydrocarbons in Site 6A soil and 15,700 pounds of petroleum hydrocarbons in Site 10B soil would be treated. The total volume of soil to be treated is approximately 7.340 cubic yards (4,150 cy of contaminated material and 3,190 cy of adjacent soils excavated with the contaminated soil). This soil would be reused on site as backfill after treatment.

Limited on-site pretreatment of the contaminated soil (i.e., dewatering to remove free product and liquids) would also be performed under this alternative prior to on-site high-temperature thermal treatment. It was estimated that up to 10 percent of the free product (860 gallons) would be recovered from the contaminated soil and transported off site to a permitted treatment/disposal facility. It is estimated that a similar volume of contaminated water (860 gallons) would be collected during dewatering activities.

The remaining nonhazardous waste generated during implementation of this alternative (560 cubic yards of concrete) would be disposed off site without treatment to reduce its toxicity, mobility, or volume.

Short-Term Effectiveness

Alternative S4 would be effective in the short term by following safe work practices. Implementation of this alternative (excavation, on-site treatment, off-site transportation of waste material) is expected to take less than 6 months to complete. Approximately 4,150 cubic yards of contaminated soil would be treated on site and would not require off-site transportation for disposal, which would reduce risks to the community. The contaminated soil would be managed on site to minimize risks to site workers and environment. All of the free product is anticipated to be hazardous and would pose risks to site workers during on-site activities and to the community during transportation. The remaining waste (all of the concrete and water) is expected to be nonhazardous and would pose lower risks to site workers and the community. Site workers would receive appropriate health and safety training and would wear the required PPE during the implementation of the alternative. Waste transportation, treatment, and disposal would be conducted in accordance with State and federal regulations to protect the community. Equipment would be decontaminated prior to leaving the sites.

Implementability

Alternative S4 is considered to be relatively implementable. Contractors and equipment are readily available to conduct excavation and off-site waste transportion activities; however, only a limited number of contractors are available with mobile high-temperature thermal desorption units to conduct on-site treatment. The excavation and thermal desorption technologies are well proven and established in the remediation and construction industries. Permits, which may be difficult to obtain, would be required to operate the high-temperature thermal desorption unit on site. Several treatment/disposal facilities are available for the nonhazardous waste (concrete and water), but only a limited number of facilities are available for the hazardous waste (free product). Depending on the waste characterization results, some of the hazardous waste may need to be transported extensive distances for treatment/disposal. Confirmation and waste characterization sampling and analysis are also readily implementable.

Cost Analysis

The following costs are estimated for Alternative S4:

Capital Costs:	$5,114,000
O&M Costs:	$0
Monitoring Costs:	$0
30-Year Present Worth:	$5,114,000

Detailed cost estimates are provided in Appendix D. The present worth costs associated with Sites 6A and 10B were estimated to be $4,228,000 and $886,000, respectively.

5.2.5 Alternative S5: Institutional Controls/Deed Notifications, In-Situ Treatment (Soil Vapor Extraction), and Monitoring

The contaminated soil and free product at Sites 6A and 10B would be treated in situ using separate SVE systems under Alternative S5. Institutional controls/deed notifications would need to be implemented. A pre-design investigation would be conducted at both sites prior to implementing the alternative to confirm the extent of contamination and the COCs.

5.2.5.1 Protection of Human Health and the Environment

Alternative S5 would be protective of human health and the environment by treating a majority of the organic contamination in situ with SVE and by limiting site access and land use within and around the sites while contaminant concentrations exceed PRGs. Also, contaminant concentrations at the sites and potential for migration would be monitored. Existing contaminants at Sites 6A and 10B do not pose current or potential future risks to ecological receptors. The SVE systems would volatilize/extract the majority of contaminants in the soil, and the contaminant vapors would be treated with GAC to comply with air discharge quality standards. Some contaminants may also naturally biodegrade, but over relatively long periods of time.

This alternative involves limiting site access and use. Because the surface soils at the sites do not represent an environmental risk, fencing is not required to limit non-intrusive activities. Restrictions would be placed to inform future workers of the contaminants in the subsurface soils and to prohibit the excavation and reuse of contaminated soil without treatment.

Soil sampling is included in this alternative to monitor the degradation of the contaminants by natural processes. Soil sampling would be required at Site 10B for 4 years and at Site 6A for more than

30 years. Periodic reviews of Site 6A (every 5 years) would be necessary to ensure that PCB concentrations were not increasing and to determine whether additional measures would be necessary to protect human health and the environment.

5.2.5.2 Media Clean-Up Standards

Alternative S5 is expected to comply with all soil PRGs, with the exception of PCBs, within 4 years. To attain the soil PRGs for PCBs would require more than 30 years. The contaminants collected by the SVE system would be treated by activated carbon. The alternative includes short-term and long-term soil monitoring to determine contaminant trends. Land use controls/deed notifications would be used to prevent exposure to soil with contaminant concentrations greater than PRGs.

5.2.5.3 Source Control

Alternative S5 would directly address a majority of the existing contaminant sources at Sites 6A and 10B (fuel- and solvent-contaminated soil/free product). The contaminated soil and free product trapped in the soil pore spaces would be addressed insitu using SVE. This action would reduce the potential for further migration of fuel and solvent contamination to groundwater. The SVE system is not expected to treat the PCBs in Site 6A soil. The PCBs are not expected to be mobile in the environment and should not be a significant source of groundwater contamination. The fuel calibration and engine testing previously conducted at the sites are no longer conducted; therefore, no additional contaminant releases should occur at the sites.

5.2.5.4 Waste Management Standards

Minimal waste would be generated under Alternative S5 because the contaminated soil at Sites 6A and 10B would be treated insitu. Contaminants collected by the SVE systems would be treated as needed prior to release to the atmosphere. The treatment residuals would be loaded into suitable containers for transportation to an off-site treatment/disposal facility. If treatment was required, the treatment residuals would be transported to an appropriate off-site facility to convert the hazardous contaminants to nonhazardous or less toxic compounds.

Equipment used to install the SVE system may come in contact with potentially hazardous chemicals (contaminated soil and free product). The equipment would be decontaminated prior to leaving the sites. Decontamination water would be collected, sampled, and if required, properly treated and disposed.

5.2.5.5 Other Factors

Long-Term Reliability and Effectiveness

Alternative S5 is expected to provide good long-term effectiveness for the fuel- and solvent-contaminated soil because SVE can be very effective at treating VOC and SVOC contaminated soil. Soil monitoring would be conducted to determine the effectiveness of this alternative.

Alternative S5 also includes land use controls/deed notifications to address the PCB-contaminated soil at Site 6A. Land use controls/deed notifications have uncertain long-term effectiveness. The protection of the potential future construction worker or resident would depend on effective administration and management of the controls. A re-evaluation of the site would be performed every 5 years to determine whether any changes to the controls would be required.

This alternative would meet the CAO of preventing contaminant leaching to groundwater. Monitoring would be conducted to determine the rate at which soil contaminants are attenuating. The monitoring results would be used to determine the duration of SVE operation and management of controls on the sites. In the event that contaminant concentrations increase, additional actions may be required.

Reduction in Toxicity, Mobility, and Volume

The effectiveness of this alternative would be determined through soil monitoring. Alternative S5 would utilize in-situ treatment of contaminated soil to reduce the toxicity, mobility, and volume of contamination. The toxicity, mobility, and volume of PCB-contaminated soil at Site 6A would not be affected by SVE. The treatment residuals from the SVE systems would be transported offsite to a permitted TSD facility. The treatment process would convert hazardous contaminants to nonhazardous or less toxic compounds that are more stable, less mobile, and/or inert.

Short-Term Effectiveness

Because contaminated soil would be treated insitu, the short-term effectiveness of Alternative S5 would be moderate. Site workers would potentially be exposed to contaminated soil and free product during installation of the SVE trenches. Site workers would receive the appropriate health and safety training and would wear the required PPE during implementation. The only potential risk to the community would be during transport of the SVE treatment residuals for off-site treatment and disposal. There are no potential environmental impacts from the implementation of this alternative. The potential human exposure to contaminated soil would be reduced through implementation of this alternative.

Implementability

Alternative S5 is considered to be implementable. Contractors and equipment are readily available to install and operate an SVE system. The remedial technology is somewhat proven and established in the remediation and construction industries. SVE is typically installed and operated in conjunction with air sparging systems to collectively remediate soil and groundwater contamination. TSD facilities are available for treatment of SVE treatment residuals contaminated with organics. Sampling and analysis are also readily implementable.

Cost Analysis

The following costs are estimated for Alternative S5:

Capital Costs:	$2,370,000
O&M Costs:	$210,000 per year (Year 1) to $169,000 per year (Year 4)
Monitoring Costs:	$1,000 per year (Annually)
	$30,000 per year (Years 1 through 4)
	$30,000 (Every 5 years)
30-year Present Worth:	$3,155,000

Detailed cost estimates are provided in Appendix D. The present worth costs associated with Sites 6A and 10B were estimated to be $2,247,000 and $908,000, respectively.

5.2.6 Alternative S6: Land Use Controls/Deed Notifications, Monitoring, and Excavation of PCB-Contaminated Hot Spots and Off-Site Treatment/Disposal

This alternative involves limiting site access and use for the petroleum- and solvent-contaminated soils at Sites 6A and 10B and long-term soil monitoring. It also involves excavating PCB-contaminated hot-spots at Site 6A and off-site treatment (as required)/disposal. A pre-design investigation would be conducted at both sites prior to implementing the alternative to confirm the extent of contamination and the COCs.

5.2.6.1 Protection of Human Health and the Environment

Alternative S6 would be protective of human health by limiting site access and land use within and around Sites 6A and 10B soils and removing PCB-contaminated hot spots at Site 6A. Also, contaminant concentrations at the sites and potential for migration would be monitored. Existing contaminants at Sites 6A and 10B do not pose current or potential future risks to ecological receptors.

Because the surface soils at the sites do not represent an environmental risk, fencing is not required to limit non-intrusive activities. Restrictions would be placed to inform future workers of the contaminants in the subsurface soils and to prohibit the excavation and reuse of contaminated soil without proper management.

Soil sampling is included in this alternative to monitor the degradation of contaminants by natural processes. Periodic review of the site (every 5 years) would be necessary to ensure that contaminant concentrations were not increasing and to determine whether additional measures would be necessary to protect human health and the environment.

5.2.6.2 Media Clean-Up Standards

Alternative S6 would eventually comply with PRGs for soil. The fuel- and solvent-related contaminants present at Sites 6A and 10B are biodegradable and/or subject to other natural attenuation processes; therefore, the PRGs for these COCs may ultimately be achieved. However, the length of time required and the potential for contamination to continue to leach to groundwater is uncertain. Land use controls/deed notifications would be used to prevent exposure to soil with contaminant concentrations greater than PRGs. The PCB concentrations above PRGs in the soil at Site 6A would be excavated and the contaminated soil would be treated and disposed off-site.

5.2.6.3 Source Control

Alternative S6 involves limited source control because the PCB-contaminated hot spots would be excavated and treated (as required)/disposed off-site. No additional source control measures would be implemented for the remaining contaminated soil as only land use controls/deed notifications would be implemented. The contaminated soil and free product at the sites would continue to act as sources of contamination to groundwater under this alternative. The fuel calibration and engine testing previously conducted at the sites are no longer conducted; therefore, no additional contaminant releases should occur at the sites.

5.2.6.4 Waste Management Standards

Alternative S6 involves the removal of PCB-contaminated soil from Site 6A; therefore, this alternative would generate wastes. Wastes generated during implementation of this alternative would be tested to determine the required methods of off-site treatment and/or disposal. The wastes would be loaded into suitable containers and transferred to appropriate off-site treatment/disposal facilities. Waste identification, transportation, treatment, and disposal would be conducted in accordance with State and federal regulations.

In addition, under this alternative incidental amounts of soil would be removed during soil monitoring activities, and this soil would be stored, transported, treated, and disposed in accordance with applicable State and federal regulations.

Equipment used on site may come into contact with potentially hazardous chemicals (contaminated soil and free product). The equipment would be decontaminated prior to leaving the sites. Decontamination waste (soil or water) would be collected, sampled, and if required, properly treated and disposed.

5.2.6.5 Other Factors

Long-Term Reliability and Effectiveness

Under Alternative S6, the potential threats to human health from the PCB-contaminated soil would be addressed through removal and off-site treatment/disposal. Limited actions [land use controls/deed notifications (transfer documents)] would be used to minimize potential threats from the remaining contaminated soil by limiting future use of the site and meeting the CAO of preventing human exposure to contaminated soils with concentrations greater than PRGs.

Excavation and off-site disposal is very effective in the long-term because the PCB-contaminated soil and free product would be removed from the site and properly disposed. The effectiveness of the alternative would be increased if the alternative was implemented when the water table is at its seasonal low (late summer). However, if PCB-contaminated soil remains at the sites undetected below the water table and the water table fluctuates in the future and exposes the contaminated soil, this alternative may not be fully protective of human health and the environment. Confirmation and waste disposal sampling and analysis would be conducted to determine the effectiveness of this alternative. No long-term monitoring would be necessary in the areas where PCB-contaminated hot spots were excavated for this alternative. During excavation activities, PPE would be used and monitoring conducted to ensure that exposure of workers to potentially contaminated material is minimized.

Land use controls/deed notifications have uncertain long-term effectiveness. The protection of the potential future construction worker would depend on effective administration and management of the controls. A re-evaluation of the site would be performed every 5 years to determine whether any changes to the controls would be required.

This alternative would not meet the CAO of preventing contaminant leaching to groundwater. Monitoring would be conducted to determine the rate at which soil contaminants are attenuating. The monitoring results would be used to determine the duration of the controls on the sites. In the event that contaminant concentrations increase, additional actions may be required.

Reduction in Toxicity, Mobility, and Volume

Alternative S6 would utilize off-site treatment as necessary to reduce the toxicity, mobility, and volume of the potential hazardous waste generated during implementation of the alternative. Approximately 410 cubic yards of PCB-contaminated soil and 310 gallons of free product/contaminated water would require off-site treatment/disposal. Limited on-site treatment of contaminated soil (i.e., dewatering to remove free product and liquids) would also be performed under this alternative. It was estimated that a similar volume of nonhazardous contaminated water (310 gallons) would be collected during dewatering activities and disposed off site without requiring treatment. The remaining nonhazardous waste (410 cubic yards of contaminated soil) would be disposed off site without treatment to reduce the toxicity or volume of the waste. The mobility of contaminants in the nonhazardous contaminated soil would be addressed by containment (landfilling).

Limited reductions in toxicity, mobility, and volume of the hazardous substances in the soil remaining at Sites 6A or 10B after the excavation of the hot-spots may result from natural processes.

Short-Term Effectiveness

Alternative S6 would be effective in the short-term by following safe work practices. Excavation and off-site transportation of the PCB-contaminated waste material is expected to take less than 2 months to complete. Some of the PCB-contaminated soil (15 cy) is anticipated to be hazardous and would pose risks to site workers during on-site activities and to the community during transportion. The remaining waste (395 cy of the PCB-contaminated soil and all of the decontamination waste) is expected to be nonhazardous and would pose lower risks to site workers and the community. Site workers would receive appropriate health and safety training and would wear the required PPE during the implementation of the alternative. Waste transportation, treatment, and disposal would be conducted in accordance with State and federal regulations to protect the community. Equipment would be decontaminated prior to leaving the sites.

For the soil remaining after excavation of the PCB-contaminated hot spots, Alternative S6 would involve soil monitoring, administration of land use controls/deed notifications, and potential restriction of residential land use for up to 30 years. The short-term risks associated with these limited remedial activities would be minimal. Sampling personnel would wear the required personal protective equipment (PPE) and receive the appropriate health and safety training. There would be no potential risk to the community or environmental impacts upon implementation of land use controls/deed notifications.

Implementability

Alternative S6 is considered to be implementable. Contractors and equipment are readily available to conduct excavation and transportion activities. The excavation technology is well proven and established in the remediation and construction industries. Several treatment/disposal facilities are available for the nonhazardous waste, but only a limited number of facilities are available for the hazardous waste. Depending on the waste characterization results, some of the hazardous waste may need to be transported extensive distances for treatment/disposal. Confirmation and waste characterization sampling and analysis are also readily implementable.

Land use controls are expected to be readily implementable because Sites 6A and 10B are currently located within a controlled facility where rules and local ordinances can be strictly enforced. Restrictions for future property use would involve legal assistance and regulatory approval. Provisions in the NWIRP Calverton transfer documents would be defined and enforced relatively easily because the site is located within a federal facility. Sampling and analysis are also readily implemented.

Cost Analysis

The following costs are estimated for Alternative S6:

Capital Costs:	$540,000
Operations and Maintenance (O&M) Costs:	$0
Monitoring Costs:	$1,000 per year (Annually)
	$35,000 per year (Every 5 years)
30-Year Present Worth:	$627,000

Detailed cost estimates are included in Appendix D. The present worth costs associated with Sites 6A and 10B were estimated to be $497,000 and $130,000, respectively.

5.2.7 Alternative S7: Excavation of PCB-Contaminated Hot Spots and Off-Site Treatment/Disposal and In-Situ Treatment of Petroleum- and Solvent Contaminated Soil by ISCO

This alternative involves excavating PCB-contaminated hot-spots at Site 6A and off-site treatment (as required)/disposal. It also involves in-situ treatment of the petroleum- and solvent-contaminated soils at Sites 6A and 10B by ISCO. A pre-design investigation would be conducted at both sites prior to implementing the alternative to confirm the extent of contamination and the COCs.

5.2.7.1 Protection of Human Health and the Environment

Alternative S7 would be protective of human health by removing PCB-contaminated hot spots at Site 6A and by treating the remaining contaminated soil at Sites 6A and 10B using ISCO. Existing contaminants at Sites 6A and 10B do not pose current or potential future risks to ecological receptors.

Because the surface soils at the sites do not represent an environmental risk, fencing is not required to limit non-intrusive activities. Temporary restrictions would be placed on the sites prior to implementing the excavation and treatment portions of the alternative to inform future workers of the contaminants in the subsurface soils and to prohibit the excavation and reuse of contaminated soil without proper management.

Because the excavation and treatment portions of the alternative should address all of the contaminated soil, periodic reviews of the site (every 5 years) would not be necessary. Confirmation sampling will be conducted after the excavation and treatment portions of the alternative to ensure that contaminant concentrations are below PRGs that are protective of human health and the environment.

5.2.7.2 Media Clean-Up Standards

Alternative S7 would comply with PRGs for soil within approximately 2 years. The PCB concentrations above PRGs in the soil at Site 6A would be excavated and the contaminated soil would be treated and disposed off-site. The fuel- and solvent-related contaminants present at Sites 6A and 10B would be treated using ISCO and up to 90 percent of the contaminant mass should be eliminated by the treatment and the PRGs for these COCs would ultimately be achieved. No institutional controls would be required to prevent exposure to soil in the future.

5.2.7.3 Source Control

Alternative S7 would directly address the existing contaminant sources at Sites 6A and 10B (contaminated soil/free product). The PCB-contaminated hot spots would be excavated and treated and disposed off-site. The fuel- and solvent-related contaminants present at Sites 6A and 10B would be treated using ISCO and up to 90 percent of the contaminant mass should be eliminated by the treatment. The fuel calibration and engine testing previously conducted at the sites are no longer conducted; therefore, no additional contaminant releases should occur at the sites.

5.2.7.4 Waste Management Standards

Alternative S7 involves the excavation and off-site disposal of PCB-contaminated soil from Site 6A; therefore, this alternative would generate wastes. Wastes generated during implementation of this alternative would be tested to determine the required methods of off-site treatment and/or disposal. The wastes would be loaded into suitable containers and transferred to appropriate off-site treatment/disposal facilities. Waste identification, transportation, treatment, and disposal would be conducted in accordance with State and federal regulations.

Equipment used on site to conduct excavation or application of the oxidants may come into contact with potentially hazardous chemicals (contaminated soil and free product). The equipment would be decontaminated prior to leaving the sites. Decontamination waste (soil or water) would be collected, sampled, and if required, properly treated and disposed.

5.2.7.5 Other Factors

<u>Long-Term Reliability and Effectiveness</u>

For Alternative S7, the potential threats to human health from the PCB-contaminated soil would be addressed through excavation and off-site treatment/disposal. The fuel- and solvent-related contaminants present at Sites 6A and 10B would be treated using ISCO. Both portions of the alternative meet the CAO of preventing human exposure to contaminated soils with concentrations greater than PRGs.

Excavation and off-site disposal is very effective in the long-term because the PCB-contaminated soil and free product would be removed from the site and properly disposed. The effectiveness of the alternative would be increased if the alternative was implemented when the water table is at its seasonal low (late summer). However, if PCB-contaminated soil remains at the sites undetected below the water table and the water table fluctuates in the future and exposes the contaminated soil, this alternative may not be fully protective of human health and the environment. Confirmation and waste disposal sampling and analysis would be conducted to determine the effectiveness of this alternative. No long-term monitoring would be necessary in the areas where PCB-contaminated hot spots were excavated for this alternative. During excavation activities, PPE would be used and monitoring conducted to ensure that exposure of workers to potentially contaminated material is minimized.

ISCO is an innovative, full-scale technology that has been successfully used for the remediation of petroleum- and solvent-contaminated source zones in soil. The oxidants react with the contaminants, producing innocuous substances such as carbon dioxide, water, and inorganic chloride. The effectiveness of the technology is dependent on the nature and extent of contamination, hydrogeologic conditions, delivery/injection system, type of oxidant, and natural organic content. Source mass reductions of up to 90 percent can be achieved through multiple applications of the oxidants. The best oxidant(s) for the contaminants at Sites 6A and 10B would be determined by a bench-scale treatability study and further evaluated during a pilot study. The natural organic content of the soil at Sites 6A and 10B is low which would reduce the amount of oxidant required to treat the contaminated soil. Two rounds of confirmation soil sampling and analysis would be conducted to determine the effectiveness of this treatment. Air monitoring would be necessary in inhabited buildings near the treated areas to ensure that contaminant vapors generated during the treatment are not migrating into the buildings. During treatment activities, PPE would be used and monitoring conducted to ensure that workers are not exposed to the oxidants or the contaminants.

This alternative would meet the CAO of preventing contaminant leaching to groundwater. Soil with contaminant concentrations above PRGs that are protective of the groundwater would be excavated and treated and disposed off-site or treated in-situ using chemical oxidation.

Reduction in Toxicity, Mobility, and Volume

Alternative S7 would utilize off-site treatment as necessary to reduce the toxicity, mobility, and volume of the PCB-contaminated hazardous waste generated during implementation of the alternative. Approximately 210 cubic yards of PCB-contaminated soil and 310 gallons of free product/contaminated water would require off-site treatment/disposal. Limited on-site treatment of contaminated soil (i.e., dewatering to remove free product and liquids) would also be performed under this alternative. It was estimated that a similar volume of nonhazardous contaminated water (310 gallons) would be collected during dewatering activities and disposed off site without requiring treatment. The remaining nonhazardous waste (210 cubic yards of contaminated soil) would be disposed off site without treatment to reduce the toxicity or volume of the waste. The mobility of contaminants in the nonhazardous contaminated soil would be addressed by containment (landfilling).

ISCO would be used to reduce the toxicity, mobility, and volume of petroleum- and solvent-contaminated soil at Sites 6A and 10. The oxidants react with the contaminants, producing innocuous substances such as carbon dioxide, water, and inorganic chloride. Based on the contaminant mass estimates for Site 6A and 10B (46,000 pounds at Site 6A and 18,000 pounds at Site 10B) and that 130 pounds of the material at Site 6A is contaminated with PCBs and will be excavated, treatment by ISCO would result in the elimination of approximately 90 percent or 58,000 pounds of organic contaminants. Approximately 3 applications of the oxidant would be required to treat the sites.

Short-Term Effectiveness

Alternative S7 would be effective in the short-term by following safe work practices. Excavation and off-site transportation of waste material is expected to take less than 2 months to complete. All of the free product and some of the contaminated soil (50 percent) are anticipated to be hazardous and would pose risks to site workers during on-site activities and to the community during transportion. The remaining waste (50 percent of the soil and water) is expected to be nonhazardous and would pose lower risks to site workers and the community. Application of ISCO, including the treatability study, pilot study, and full scale implementation, is expected to take more than 1 year. The oxidants used for ISCO pose potential health and safety hazards (direct contact and vigorous uncontrolled reactions) to site workers during on-site activities and to the community during transportation.

Site workers would receive appropriate health and safety training and would wear the required PPE during the implementation of the alternative. Waste transportation, treatment, and disposal would be conducted in accordance with State and federal regulations to protect the community. Equipment would be decontaminated prior to leaving the sites.

Implementability

Alternative S7 is considered to be somewhat implementable. Contractors and equipment are readily available to conduct excavation and transportion activities. The excavation technology is well proven and established in the remediation and construction industries. Several treatment/disposal facilities are available for the nonhazardous waste, but only a limited number of facilities are available for the hazardous waste. Depending on the waste characterization results, some of the hazardous waste may need to be transported extensive distances for treatment/disposal. Confirmation and waste characterization sampling and analysis are also readily implementable.

A limited number of vendors are available to supply the remediation-grade oxidants required for ISCO. Approximately 3,700 tons (7,463,000 pounds) of oxidants (e.g., percarbonate) would be necessary to treat approximately 90 percent of the contaminants at Sites 6A and 10B. Shipment, storage, and application of this quantity of oxidants would be difficult. A limited number of contractors and equipment are available to apply the oxidants in-situ. The ISCO technology is innovative but it has been proven in the remediation industry. A bench-scale treatability study would be necessary to determine the appropriate oxidant for the site-specific contaminants. A pilot study would also be necessary to verify the effectiveness of the oxidant in the field. Permits would be required because the oxidants and their impurities may impact the groundwater below the treatment zone. Utility surveys would need to be conducted to account for the effect of underground piping, utilities, or trenches on preferential pathways.

Air monitoring would be necessary in inhabited buildings near the treated areas to ensure that contaminant vapors generated during the treatment are not migrating into the buildings.

Cost Analysis

The following costs are estimated for Alternative S7:

Capital Costs:	$32,217,000
O&M Costs:	$0
Monitoring Costs:	$0 per year
30-Year Present Worth:	$32,217,000

Detailed cost estimates are provided in Appendix D. The present worth costs associated with Sites 6A and 10B were estimated to be $25,655,000 and $6,562,000, respectively.

5.3 EVALUATION OF SITE 6A AND SITE 10B GROUNDWATER CORRECTIVE MEASURES ALTERNATIVES

5.3.1 Alternative SAGW1: No Action

Alternative SAGW1 addresses Sites 6A and 10B source area groundwaters. Under this alternatives there would be no activities.

5.3.1.1 Protection of Human Health and the Environment

Alternative SAGW1 is considered primarily for comparison to the other corrective measures. This alternative is somewhat protective of human health. Although contaminants would remain in the groundwater for extended periods of time, they would slowly biodegrade and attenuate. Because there are no current users of groundwater, there are no current risks to human health. Under future potential scenarios, people could be directly exposed to groundwater if groundwater wells would be installed and the groundwater used for potable purposes. Under this scenario, Alternative SAGW1 would not be protective of human health.

Based on the type of contamination (fuels and solvents), the distance from the sites to a surface water body (Peconic River), and natural attenuation factors, contamination from the sites would not be expected to pose a significant potential risk to ecological receptors.

5.3.1.2 Media Clean-Up Standards

Alternative SAGW1 would not comply with groundwater PRGs at Sites 6A and 10B. The groundwater leaving the sites is currently not in compliance with these requirements. Future migration of contaminated groundwater offsite would not be known.

5.3.1.3 Source Control

Alternative SAGW1 involves no additional source control because no actions would be performed at Sites 6A and 10B. The fuel calibration and engine testing previously conducted at the sites are no longer conducted; therefore, no additional contaminant releases should occur at the sites.

5.3.1.4 Waste Management Standards

There are no actions to be implemented for Alternative SAGW1; therefore, no waste would be generated.

5.3.1.5 Other Factors

<u>Long-Term Reliability and Effectiveness</u>

The future potential threat to human health would remain because there would be no access controls or removal or treatment of the contaminants. Organic contaminants would decrease through natural attenuation but would remain in groundwater at Sites 6A and 10B at levels greater than the media clean-up standards and may migrate off site. Because monitoring would not be conducted, the long-term reliability and effectiveness of this alternative would not be known.

<u>Reduction in Toxicity, Mobility, and Volume</u>

Alternative SAGW1 involves no reduction in toxicity, mobility, or volume of contaminants at Sites 6A and 10B other than that which would result from natural dispersion, dilution, or other attenuating factors. There are no treatment processes employed; therefore, no materials are treated or destroyed.

<u>Short-Term Effectiveness</u>

Alternative SAGW1 involves no action; therefore, it would not pose any risks to on-site workers during implementation. No environmental impacts would be expected. This alternative would not achieve any of the CAOs.

Implementability

Because no actions would occur, this alternative is readily implementable. The technical feasibility criteria, including constructability, operability, and reliability, are not applicable.

Cost Analysis

There are no costs associated with the No Action alternative.

5.3.2 Alternative SAGW2: Land Use Controls/Deed Notifications, Natural Attenuation, and Monitoring

This alternative involves limiting site access and use for source area groundwater at Sites 6A and 10B.

5.3.2.1 Protection of Human Health and the Environment

Alternative SAGW2 would be protective of human health by limiting site access and land use within and around Sites 6A and 10B. Also, contaminant concentrations at the sites and the potential for migration would be monitored. Existing contaminants at Sites 6A and 10B do not pose current or potential future risks to ecological receptors.

Restrictions would be placed to inform future workers of the contaminants in the groundwater and to prohibit the use of site groundwater for potable water.

Sampling of groundwater is included to monitor potential groundwater contamination migration and to determine the effectiveness of natural attenuation. Periodic review of the site (every 5 years) would be necessary to ensure that contaminant concentrations were not increasing or migrating off site and to determine whether additional measures would be necessary to protect human health and the environment.

5.3.2.2 Media Clean-Up Standards

In the short term, Alternative SAGW2 would not comply with groundwater PRGs. Because the contaminants present are biodegradable and/or subject to other natural attenuation processes, groundwater would ultimately achieve the media clean-up standards. However, the length of time required and the potential for contamination to migrate to uncontaminated areas is uncertain. Predictions indicate that it could take 7 to 14 years for VOCs and over 30 years to attain all the PRGs. Remediation times would be even longer if soil remediation is not conducted. Land use controls/deed notifications would be used to prevent exposure to media with contaminant concentrations greater than clean-up standards.

5.3.2.3 Source Control

Alternative SAGW2 does not involve additional source control because only land use controls/deed notifications would be implemented. If left uncontrolled, the contaminant sources at Site 6A and 10B (contaminated soil/free product) would continue to contribute contamination to groundwater at each site. For this alternative, it was assumed that a majority of both sources would be addressed by one of the soil alternatives and that any residual impact from these sources would be evaluated through monitoring. The fuel calibration and engine testing previously conducted at the sites are no longer conducted; therefore, no additional contaminant releases should occur at the sites.

5.3.2.4 Waste Management Standards

Alternative SAGW2 involves no direct removal of contaminated groundwater; therefore, this alternative would not generate any significant wastes. However, under this alternative, incidental amounts of groundwater would be removed during groundwater monitoring activities, and this groundwater would be stored, transported, treated, and disposed in accordance with applicable State and federal regulations.

5.3.2.5 Other Factors

<u>Long-Term Reliability and Effectiveness</u>

Although no groundwater removal would occur in Alternative SAGW2, the potential threats to human health would be minimized. This limited action alternative would use land use controls/deed notifications such as the NWIRP Calverton transfer documents to limit future use of the site.

Institutional controls have uncertain long-term effectiveness. The protection of the potential future construction worker and resident would depend on effective administration and management of the transfer documents. A re-evaluation of the site would be performed every 5 years to determine whether any changes to the controls would be required.

Also, because there is the possibility that contaminated groundwater would migrate faster than it is attenuating, currently uncontaminated areas could be impacted. Monitoring would be used to address this concern and to evaluate the effectiveness of natural attenuation. In the event that contaminant concentrations are increasing in the downgradient areas and moving off site, additional actions may be required.

Reduction in Toxicity, Mobility, and Volume

Alternative SAGW2 would not result in reduction in toxicity, mobility, or volume through treatment of the hazardous substances at Sites 6A and 10B other than that which would result from natural dispersion, dilution, or other attenuating factors.

Short-Term Effectiveness

Alternative SAGW2 would involve groundwater monitoring, administration of land use controls/deed notifications, and potential restriction of residential land use. The short-term risks associated with these limited remedial activities would be minimal. Sampling personnel would wear the required PPE and receive the appropriate health and safety training. There would be no potential risk to the community or environmental impacts upon the implementation of land use controls/deed notifications.

Implementability

Alternative SAGW2 is expected to be readily implementable because Sites 6A and 10B are located within a controlled facility where rules and local ordinances can be strictly enforced. Restrictions for future property use would involve legal assistance and regulatory approval. Provisions in the NWIRP Calverton transfer documents would be defined and enforced relatively easily because the site is located within a federal facility. Sampling and analysis are also readily implemented.

Cost Analysis

The following costs are estimated for Alternative SAGW2:

Capital Costs:	$181,000
O&M Costs:	$0
Monitoring Costs:	$69,700 per year (Year 1)
	$20,900 per year to $25,700 per year (Years 2 through 30)
	$23,000 (Every 5 years)
30-Year Present Worth:	$564,000

Detailed cost estimates are included in Appendix D. The present worth costs associated with Sites 6A and 10B were estimated to be $451,000 and $113,000, respectively.

5.3.3 Alternative SAGW3: Land Use Controls/Deed Notifications, Groundwater Extraction (Wells), Treatment (Air Stripping/Activated Carbon), Reinjection (Infiltration Galleries), and Monitoring

Alternative SAGW3 involves implementing land use controls/deed notifications for Sites 6A and 10B groundwater, extracting, treating, and re-injecting the contaminated groundwater, and monitoring the progress of groundwater remediation. Land use controls/deed notifications would be implemented at the sites as discussed in Alternative SAGW2.

5.3.3.1 Protection of Human Health and the Environment

Alternative SAGW3 would be protective of human health and the environment by containing and treating contaminated groundwater at Sites 6A and 10B. Because of contaminant mobility issues, it is expected that the remediation of VOCs will occur quicker than for SVOCs. During implementation, site contaminants would also be treated insitu via natural biodegradation and other attenuation factors. The extracted groundwater would be treated using air stripping prior to reinjection. Long-term groundwater monitoring would be conducted to determine the effectiveness of this alternative. Restrictions on groundwater use would be implemented to prevent exposure to contaminated groundwater during the remediation process.

5.3.3.2 Media Clean-Up Standards

In the short term, Alternative SAGW3 would not comply with the groundwater PRGs. Contaminated groundwater would be extracted to prevent off-site contaminant migration and then treated prior to reinjection. It is expected that groundwater contaminants would ultimately decrease to PRGs through groundwater extraction and treatment and natural attenuation processes. However, the length of time required to achieve PRGs at each site is expected to vary between 9 and 30 years. Remediation times would be even longer if soil remediation is not conducted. Land use controls/deed notifications would be used to prevent exposure to groundwater while the contaminant concentrations are greater than PRGs.

5.3.3.3 Source Control

This alternative would extract and treat contaminated groundwater and reduce the potential for direct contact with contaminated groundwater and further contaminant migration. If left uncontrolled, the contaminant sources at Site 6A and 10B (contaminated soil/free product) would continue to contribute contamination to groundwater at each site. For this alternative, it was assumed that a majority of both sources would be addressed by one of the soil alternatives and that any residual impact from these sources would be addressed by groundwater extraction and treatment. The fuel calibration and engine testing previously conducted at the sites are no longer conducted; therefore, no additional contaminant releases should occur at the sites.

5.3.3.4 Waste Management Standards

Groundwater extracted from both sites would be treated on site and reinjected to the surficial aquifer. Reinjection of the effluent would be managed under State and federal regulations, and permits would be required. Treatment residues generated during the groundwater treatment process would include metal sludges and possibly spent GAC. The offgas from the air stripper would be treated if required. Sludges and/or possibly GAC residuals would be loaded into suitable containers and transferred to appropriate off-site treatment/disposal facilities.

Incidental amounts of soil cuttings generated during installation of extraction and monitoring wells and of groundwater generated during groundwater monitoring would be managed in accordance with State and federal regulations. They would be loaded into suitable containers and transferred to appropriate off-site treatment/disposal facilities.

Equipment used on site during implementation of this alternative may come in contact with potentially hazardous chemicals (contaminated groundwater). The equipment would be decontaminated prior to leaving the sites. Decontamination water would be collected, sampled, and if required, properly treated and disposed.

5.3.3.5 Other Factors

<u>Long-Term Reliability and Effectiveness</u>

Alternative SAGW3 would provide good long-term effectiveness because groundwater extraction would be very effective at containing contaminated groundwater. Long-term groundwater monitoring would be conducted to determine the effectiveness of this alternative.

Contaminant concentrations in groundwater commonly level off at concentrations greater than PRGs during implementation of groundwater extraction alternatives. If this occurs, the alternative would continue to be effective for containment, but it would not be effective for contaminant reduction. If containment is no longer a concern, the systems can be shut down and the alternative switched to natural attenuation.

Groundwater extraction and treatment systems require periodic maintenance of mechanical components. Components susceptible to failure include wells (clogged screens due to iron scaling or fine-grained material), pumps, and electrical components. Proper operation and maintenance of the systems would be required to maintain their reliability and effectiveness.

The effectiveness of the groundwater treatment systems would be monitored through confirmation sampling of the treated effluent and gas emissions of the air stripper. The effectiveness of the treatment of the treatment system residuals would be confirmed by sampling and testing before the material is shipped off site for treatment/disposal.

During the installation and monitoring of the systems, PPE would be used and monitoring conducted to ensure that exposure of workers to potentially contaminated material is minimized.

Reduction in Toxicity, Mobility, and Volume

Alternative SAGW3 would utilize treatment of contaminated groundwater to reduce the toxicity, mobility, and volume of the waste. The toxicity of VOCs and SVOCs would be eliminated through photochemical degradation in the atmosphere, thermal destruction during regeneration of activated carbon, if required, and/or natural in-situ biodegradation. The treatment residuals would be transported off site to a permitted treatment/disposal facility.

Short-Term Effectiveness

Alternative SAGW3 would be effective in the short-term by following safe work practices. The contaminant concentrations in groundwater at Sites 6A and 10B are expected to be relatively low, and exposure to groundwater by site workers would be managed by appropriate health and safety practices and PPE during implementation. If air stripping is used to treat the groundwater, the offgas would be treated as required to comply with State requirements. One potential risk to the community would be during transport of contaminated treatment residuals off site for treatment and disposal. Because the residues to be collected are not anticipated to be hazardous, this risk is anticipated to be minimal.

Implementability

Alternative SAGW3 is considered to be implementable. Drilling contractors and equipment are readily available for extraction and monitoring well installation, and treatment equipment is also readily available for ex-situ treatment of the groundwater. The remedial technologies are well proven and established in the remediation and construction industries. Groundwater extraction and treatment systems would require operations and maintenance. Contractors and equipment are available to conduct operations and maintenance. Treatment/disposal facilities are available for the treatment system residuals. Sampling and analysis are also readily implementable.

Cost Analysis

The following costs are estimated for Alternative SAGW3:

Capital Costs:	$1,653,000
O&M Costs:	$98,000 per year to $177,000 per year (Years 1 to 30)
Monitoring Costs:	$20,900 per year to $69,700 per year (Years 1 through 30)
	$23,000 (Every 5 years)
30-Year Present Worth:	$3,692,000

Detailed cost estimates are provided in Appendix D. The present worth costs associated with Sites 6A and 10B were estimated to be $2,954,000 and $738,000, respectively.

5.3.4 Alternative SAGW4: Land Use Controls/Deed Notifications, In-Situ Treatment (Air Sparging), and Monitoring

Alternative SAGW4 was developed as an in-situ treatment alternative and consists of implementing land use controls/deed notifications, installing air sparging/bioventing systems, and conducting groundwater monitoring for Sites 6A and 10B groundwater.

5.3.4.1 Protection of Human Health and the Environment

Alternative SAGW4 would be protective of human health and the environment by treating the organic contamination in place. Sparging/bioventing would volatilize/degrade the majority of contaminants in groundwater. The volatilized contaminants would be collected by the SVE system (Alternative S5) and vapor-phase GAC would be used as needed to comply with air discharge quality standards.

Some SVOCs would take longer to remediate than VOCs. The land use controls/deed notifications would control access and use of the contaminated groundwater until contaminant concentrations decrease to PRGs. Groundwater monitoring would be conducted to determine the effectiveness of the alternative and whether additional action for groundwater would be necessary. The results of the monitoring would be used to determine when groundwater concentrations were less than PRGs and restrictions on groundwater use could be removed.

5.3.4.2 Media Clean-Up Standards

It is expected that Alternative SAGW4 would comply with groundwater PRGs after 4 years. Air sparging/bioventing would volatilize/degrade the majority of contaminants in groundwater. The volatilized contaminants would be collected and treated by the SVE systems (Alternative S5). The alternative includes groundwater monitoring to determine contaminant concentration trends. Institutional controls would be used to prevent exposure to groundwater while contaminant concentrations are greater than PRGs.

5.3.4.3 Source Control

This alternative would physically treat contaminated groundwater and reduce the potential for direct contact with contaminated groundwater and further contaminant migration. If left uncontrolled, the contaminant sources at Site 6A and 10B (contaminated soil/free product) would continue to contribute contamination to groundwater at each site. It was assumed for this alternative that a majority of both sources would be addressed by one of the soil alternatives, probably Alternative S5, and any residual impact from these sources would be addressed by the air sparging systems. The fuel calibration and engine testing previously conducted at the sites are no longer conducted; therefore, no additional contaminant releases should occur at the sites.

5.3.4.4 Waste Management Standards

During implementation of Alternative SAGW4, contaminated groundwater would be treated in situ and minimal waste would be generated that would require off-site treatment and disposal. Waste management practices would be used during implementation of the alternative to avoid spreading contamination. Contaminated groundwater would be air sparged, and the air with volatilized contaminants would be collected and treated under Alternative S5 with SVE systems as needed prior to release to the atmosphere. The treatment residuals from air treatment are also addressed under Alternative S5.

Minor amounts of drill cuttings would be generated during the installation of the air sparging systems and monitoring wells. The cuttings would be loaded into suitable containers for transportation to an off-site treatment/disposal facility. Equipment used on site may come in contact with potentially hazardous chemicals (contaminated groundwater and soil). The equipment would be decontaminated prior to leaving the sites. Decontamination water would be collected, sampled, and if required, properly treated and disposed.

5.3.4.5 Other Factors

<u>Long-Term Reliability and Effectiveness</u>

Alternative SAGW4 would provide good long-term effectiveness because air sparging/bioventing can be very effective at treating VOC- and SVOC-contaminated groundwater. It is anticipated that the SVE systems in Alternative S5 would be implemented with Alternative SAGW4 to improve reliability and effectiveness. Groundwater monitoring would be conducted to determine the effectiveness of this alternative.

The air sparging systems would require periodic maintenance of mechanical components. Components susceptible to failure include wells (clogged screens), blowers, and electrical components. Proper O&M of the systems would be required to maintain their reliability and effectiveness.

Contaminant concentrations in groundwater commonly level off at concentrations greater than PRGs during implementation of in-situ groundwater treatment alternatives. If this occurs, the system would typically be shut down and the remedy switched to natural attenuation (Alternative SAGW2). However, for this alternative, it was assumed that groundwater clean-up will occur within the 4-year period.

During the installation and monitoring of the systems, PPE would be used and monitoring conducted to ensure that exposure of the workers to potentially contaminated material is minimized.

<u>Reduction in Toxicity, Mobility, and Volume</u>

Alternative SAGW4 would reduce the toxicity, mobility and volume of contamination in groundwater at Sites 6A and 10B through air sparging (physical treatment) and in-situ bioremediation. When implemented with Alternative S5, the contaminated air generated by the air sparging systems would be collected and treated ex situ to reduce the toxicity, mobility, and volume of contamination. The treatment residuals would be transported off site to a permitted TSD facility. The treatment process would convert hazardous contaminants to nonhazardous or less toxic compounds that are more stable, less mobile, and/or inert.

<u>Short-Term Effectiveness</u>

Alternative SAGW4 would be effective in the short term by following safe work practices. Site workers would receive the appropriate health and safety training and would wear the required PPE during implementation. Potential risks to the community would result if the contaminated air generated from the air sparging systems was not captured and treated prior to discharge to the atmosphere. These potential risks would be eliminated if the alternative is implemented with Alternative S5. The minor amounts of contaminated material generated during implementation of this alternative should have no significant impact to the community during transportation off site for treatment/disposal. There are no potential environmental impacts from the implementation of this alternative. The potential human exposure to contaminated groundwater would be reduced through implementation of this alternative.

Implementability

Alternative SAGW4 is considered to be implementable. Drilling contractors and equipment are readily available for injection and monitoring well installation. The remedial technology is generally well proven and established in the remediation and construction industries. Disposal facilities are available for nonhazardous contaminated soil. Sampling and analysis are also readily implementable.

Cost Analysis

The following costs are estimated for Alternative SAGW4:

Capital Costs:	$967,000
O&M Costs:	$118,600 per year (Years 1 through 4)
Monitoring Costs:	$69,700 per year (Year 1)
	$25,700 per year (Years 2 through 4)
30-Year Present Worth:	$1,497,000

Detailed cost estimates are provided in Appendix D. The present worth costs associated with Sites 6A and 10B were estimated to be $1,198,000 and $299,000, respectively.

5.3.5 Alternative SAGW5: Land Use Controls/Deed Notifications, In-Situ Biological Treatment (Biostimulation with HRC® and ORC®), Natural Attenuation, and Monitoring

Alternative SAGW5 was developed as an active in-situ bioremediation alternative for Sites 6A and 10B groundwater. This alternative consists of implementing land use controls/deed notifications, adding HRC® and ORC® to the overburden aquifer to biologically treat COCs, and conducting groundwater monitoring.

5.3.5.1 Protection of Human Health and the Environment

Alternative SAGW5 would be protective of human health and the environment by treating the groundwater at Sites 6A and 10B. HRC®- and ORC®-assisted bioremediation would degrade the majority of contaminants in groundwater. Groundwater monitoring would be conducted to determine the effectiveness of the alternative and whether additional action for groundwater would be necessary. Controls would be implemented to ensure that contaminated groundwater would not be extracted or used for drinking until groundwater concentrations were less than PRGs.

5.3.5.2 Media Clean-Up Standards

Alternative SAGW5 would eventually comply with groundwater PRGs. The use of HRC® and ORC® would address most contaminants in groundwater. Natural attenuation processes would ultimately reduce remaining contaminant concentrations to PRGs. Monitoring would be conducted to determine contaminant concentration trends. Land use controls/deed notifications would be used to prevent exposure to groundwater with contaminant concentrations greater than PRGs.

5.3.5.3 Source Control

This alternative would use HRC® and ORC® assisted bioremediation to treat in situ groundwater with contaminant concentrations in excess of PRGs. This action would reduce the potential for further migration of contaminated groundwater that could pose a threat to human health. If left uncontrolled, the contaminant sources at Site 6A and 10B (contaminated soil/free product) would continue to contribute contamination to groundwater at each site. It was assumed for this alternative that a majority of both sources would be addressed by one of the soil alternatives and that any residual impact from these sources would be addressed by this alternative. The fuel calibration and engine testing previously conducted at the sites are no longer conducted; therefore, no additional contaminant releases should occur at the sites.

5.3.5.4 Waste Management Standards

During implementation of Alternative SAGW5, contaminated groundwater would be treated in situ using HRC®- and ORC®-assisted bioremediation, and minimal waste would be generated that would require off-site treatment and disposal. Waste management practices would be used during implementation of the alternative to avoid spreading contamination. Minor amounts of drill cuttings and purge water would be generated during monitoring well installation and monitoring. These wastes would be loaded into suitable containers for transportation to an off-site treatment/disposal facility.

Equipment used on site may come in contact with potentially hazardous chemicals (contaminated groundwater and soil). The equipment would be decontaminated prior to leaving the sites. Decontamination water would be collected, sampled, and if required, properly treated and disposed.

5.3.5.5 Other Factors

Long-Term Reliability and Effectiveness

Alternative SAGW5 is expected to provide good long-term effectiveness because HRC®- and ORC®-assisted bioremediation can be very effective at treating fuel- and solvent-contaminated groundwater. Long-term groundwater monitoring would be conducted to determine the effectiveness of this alternative.

Contaminant concentrations in groundwater commonly level off at concentrations greater than PRGs during implementation of in-situ groundwater treatment alternatives. This alternative includes implementation of natural attenuation after HRC® and ORC® injection to complete groundwater remediation to PRGs.

During HRC® and ORC® installation and groundwater monitoring, PPE would be used and monitoring conducted to ensure that exposure of workers to potentially contaminated material is minimized.

Reduction in Toxicity, Mobility, and Volume

Alternative SAGW5 would utilize treatment of contaminated groundwater by in situ bioremediation to reduce the toxicity, mobility, and volume of the waste. The treatment process would convert hazardous contaminants to nonhazardous or less toxic compounds that are more stable, less mobile, and/or inert.

Short-Term Effectiveness

Alternative SAGW5 would be effective in the short term by following safe work practices. Site workers would receive the appropriate health and safety training and would wear the required PPE during implementation. HRC® and ORC® are nonhazardous products. The minor amounts of contaminated material generated during groundwater monitoring for this alternative should have no significant impact to the community during transportation off site for treatment/disposal. There are no potential environmental impacts from the implementation of this alternative. The potential human exposure to contaminated groundwater would be reduced through implementation of this alternative.

Implementability

Alternative SAGW5 is considered to be implementable. It involves biostimulation/bioremediation with HRC® and ORC®, which is considered an innovative technology. Contractors and equipment are available for injection of HRC® and ORC® and installation of additional wells. The remedial technology has been the subject of studies that have established it as viable for fuel- and solvent-contaminated groundwater. Sampling and analysis are also readily implementable.

Cost Analysis

The following costs are estimated for Alternative SAGW5:

Capital Costs:	$1,899,000
O&M Costs:	$0
Monitoring Costs:	$59,700 per year (Years 1 through 3)
	$15,700 per year (Years 4 through 6)
	$23,000 per year (every 5 years)
30-Year Present Worth:	$2,105,000

Detailed cost estimates are provided in Appendix D. The present worth costs associated with Sites 6A and 10B were estimated to be $1,684,000 and $421,000, respectively.

5.4 EVALUATION OF ON-SITE SOUTHERN AREA PLUME GROUNDWATER CORRECTIVE MEASURES ALTERNATIVES

5.4.1 Alternative OSAGP1: No Action

Alternative OSAGP1 addresses the On-Site Southern Area Groundwater Plume. Under this alternative, there would be no activities.

5.4.1.1 Protection of Human Health and the Environment

Alternative OSAGP1 is considered primarily for comparison to the other corrective measures. This alternative is somewhat protective of human health. Although contaminants would remain in groundwater for extended periods of time, they would slowly biodegrade and attenuate. Because there are no current users of groundwater, there are no current risks to human health. Under future potential scenarios, people could be directly exposed to groundwater if groundwater wells would be installed and the groundwater used for potable purposes. Under these scenarios, Alternative OSAGP1 would not be protective of human health.

Based on the type of contamination (fuels and solvents), the distance from this site to a surface water body (greater than 1,000 feet to the Peconic River), and natural attenuation factors, contamination from this site would not be expected to pose a significant potential risk to ecological receptors.

5.4.1.2 Media Clean-Up Standards

Alternative OSAGP1 would not comply with groundwater- and drinking water-based criteria within the plume. Groundwater leaving the site would also not comply with these requirements. Future contaminant migration off site would not be known.

5.4.1.3 Source Control

Alternative OSAGP1 involves no additional source control because no action would be performed for the On-Site Southern Area Plume. One of the potential sources of contamination to the On-Site Southern Area Plume (i.e., discharges of contaminated groundwater from the former free product recovery system to drainage swales, overland transport, and reinfiltration) has been eliminated. If left uncontrolled, the contaminant sources at Site 6A and 10B would continue to contribute contamination to the On-Site Southern Area Plume. The magnitude of the impact from these sources would be unknown because no monitoring would be conducted under this alternative.

5.4.1.4 Waste Management Standards

There are no actions to be implemented for Alternative OSAGP1; therefore, no waste would be generated.

5.4.1.5 Other Factors

<u>Long-Term Reliability and Effectiveness</u>

The future potential threat to human health would remain because there would be no access controls or removal or treatment of the contaminants. Organic contaminants would decrease through natural attenuation but would remain in the On-Site Southern Area Plume at levels greater than the media clean-up standards and may migrate off site. Because monitoring would not be conducted, the long-term reliability and effectiveness of this alternative would not be known.

<u>Reduction in Toxicity, Mobility, and Volume</u>

Alternative OSAGP1 involves no reduction in toxicity, mobility, or volume of contaminants in the On-Site Southern Area Plume other than that which would result from natural dispersion, dilution, or other attenuating factors. There are no treatment processes employed; therefore, no materials are treated or destroyed.

Short-Term Effectiveness

Alternative OSAGP1 involves no action; therefore, it would not pose any risks to on-site workers during implementation. No environmental impacts would be expected. This alternative would not achieve any of the CAOs.

Implementability

Because no actions would occur, this alternative is readily implementable. The technical feasibility criteria, including constructability, operability, and reliability, are not applicable.

Cost Analysis

There are no costs associated with the No Action alternative.

5.4.2 Alternative OSAGP2: Land Use Controls/Deed Notifications, Natural Attenuation, and Monitoring

This alternative involves limiting site access and use for On-Site Southern Area groundwater.

5.4.2.1 Protection of Human Health and the Environment

Alternative OSAGP2 would be protective of human health by limiting site access and land use within the On-Site Southern Area Plume. Also, contaminant concentrations within the plume and the potential for migration would be monitored. Existing contaminants within the plume do not pose current or potential future risks to ecological receptors.

Restrictions would be placed to inform future workers of contaminants in groundwater and to prohibit the use of site groundwater for potable water.

Sampling of groundwater is included to monitor potential groundwater contamination migration and to determine the effectiveness of natural attenuation. Periodic review of the site (every 5 years) would be necessary to ensure that contaminant concentrations were not increasing or migrating off site and to determine whether additional measures would be necessary to protect human health and the environment.

5.4.2.2 Media Clean-Up Standards

In the short term, Alternative OSAGP2 would not comply with groundwater PRGs. Because the contaminants present are biodegradable and/or subject to other natural attenuation processes, groundwater would ultimately achieve the groundwater PRGs. However, the length of time required and the potential for contamination to migrate to currently uncontaminated areas is uncertain. Predictions indicate that it could take over 30 years to attain PRGs for some COCs. Institutional controls would be used to prevent exposure to groundwater with contaminant concentrations greater than clean-up standards.

5.4.2.3 Source Control

Alternative OSAGP2 does not involve additional source control because only land use controls/deed notifications would be implemented. One of the potential sources of contamination to the On-Site Southern Area Plume (i.e., discharges of contaminated groundwater from the former free product recovery system to drainage swales, overland transport, and reinfiltration) has been eliminated. If left uncontrolled, the contaminant sources at Site 6A and 10B would continue to contribute contamination to the On-Site Southern Area Plume. For this alternative, the magnitude of the impact from these sources would be evaluated through monitoring.

5.4.2.4 Waste Management Standards

Alternative OSAGP2 involves no direct removal of contaminated groundwater; therefore, this alternative would not generate any wastes. However, under this alternative incidental amounts of groundwater would be removed during groundwater monitoring activities, and this groundwater would be stored, transported, treated, and disposed in accordance with applicable State and federal regulations.

5.4.2.5 Other Factors

<u>Long-Term Reliability and Effectiveness</u>

Although no removal would occur in Alternative OSAGP2, the potential threats to human health would be minimized. This limited action alternative would use land use controls/deed notifications such as the NWIRP Calverton transfer documents to limit future use of the site.

Land use controls/deed notifications have uncertain long-term effectiveness. The protection of the potential future construction worker or resident would depend on effective administration and management of the transfer documents. A re-evaluation of the site would be performed every 5 years to determine whether any changes to the controls would be required.

Also, because there is the possibility that contaminated groundwater would migrate faster than it is attenuating, currently uncontaminated areas could be impacted. Monitoring would be used to address this concern and to evaluate the effectiveness of natural attenuation. In the event that contaminant concentrations are increasing in the downgradient areas and moving off site, additional actions may be required.

Reduction in Toxicity, Mobility, and Volume

Alternative OSAGP2 would not result in reduction in toxicity, mobility, or volume through treatment of the hazardous substances within the On-Site Southern Area Plume other than that which would result from natural dispersion, dilution, or other attenuating factors.

Short-Term Effectiveness

Alternative OSAGP2 would involve groundwater monitoring, administration of land use controls/deed notifications, and potential restriction of residential land use. The short-term risks associated with these limited remedial activities would be minimal. Sampling personnel would wear the required PPE and receive the appropriate health and safety training. There would be no potential risk to the community or environmental impacts upon the implementation of institutional controls.

Implementability

Alternative OSAGP2 is expected to be readily implementable because the On-Site Southern Area Plume is located within a controlled facility where rules and local ordinances can be strictly enforced. Restrictions for future property use would involve legal assistance and regulatory approval. Provisions in the NWIRP Calverton transfer documents would be defined and enforced relatively easily because the site is located within a federal facility. Sampling and analysis are also readily implemented.

Cost Analysis

The following costs are estimated for Alternative OSAGP2:

Capital Costs:	$108,000
O&M Costs:	$0
Monitoring Costs:	$60,900 per year (Year 1)
	$23,500 per year (Year 2 through 30)
	$23,000 per year (Every 5 years)
300Year Present Worth:	$484,000

Detailed cost estimates are included in Appendix D.

5.4.3 Alternative OSAGP3: Land Use Controls/Deed Notifications, Groundwater Extraction (Wells), Treatment (Air Stripping/Activated Carbon), Reinjection (Infiltration Galleries), and Monitoring

This alternative consists of implementing land use controls/deed notifications for the On-Site Southern Area Plume, extracting the contaminated groundwater, treating and reinjecting the water, and monitoring the progress of groundwater remediation.

5.4.3.1 Protection of Human Health and the Environment

Alternative OSAGP3 would be protective of human health and the environment by containing and treating contaminated groundwater in the On-Site Southern Area Plume. Because of contaminant mobility issues, it is expected that the remediation of the VOCs will occur quicker than for the SVOCs. During implementation, site contaminants would also be treated in situ via natural biodegradation and other attenuation processes. The extracted groundwater would be treated using air stripping prior to reinjection. Long-term groundwater monitoring would be conducted to determine the effectiveness of this alternative. Restrictions on groundwater use would be implemented to prevent exposure to contaminated groundwater during the remediation process.

5.4.3.2 Media Clean-Up Standards

In the short term, Alternative OSAGP3 would not comply with groundwater PRGs. Contaminated groundwater would be extracted to prevent off-site contaminant migration and then treated prior to reinjection. It is expected that groundwater contaminants would ultimately decrease to PRGs through groundwater extraction and treatment and natural attenuation processes. However, the length of time required to achieve the PRGs is expected to be 11 years. Land use controls/deed notifications would be used to prevent exposure to groundwater while contaminant concentrations are greater than PRGs.

5.4.3.3 Source Control

This alternative would extract and treat contaminated groundwater and reduce the potential for direct contact with contaminated groundwater and further contaminant migration. The major historic source of contamination to the On-Site Southern Area Plume (i.e., discharges of contaminated groundwater from the former free product recovery system to drainage swales, overland transport, and reinfiltration) has been eliminated. If left uncontrolled, the contaminant sources at Site 6A and 10B (contaminated soil/free product) would continue to contribute contamination to the On-Site Southern Area Plume. For this alternative, it was assumed that a majority of both sources would be addressed by one of the soil alternatives and that any residual impact from these sources would be addressed by groundwater extraction and treatment. The fuel calibration and engine testing previously conducted at Sites 6A and 10B are no longer conducted; therefore, no additional contaminant releases should occur at these sites.

5.4.3.4 Waste Management Standards

Groundwater extracted from the On-Site Southern Area Plume would be treated on site and reinjected to the surficial aquifer. Reinjection of the effluent would be managed under State and federal regulations, and permits would be required. Treatment residues generated during the groundwater treatment process include metal sludges and possibly spent GAC. The off gas from the air stripper would be treated if required. Sludges and/or possibly GAC residuals would be loaded into suitable containers and transferred to appropriate off-site treatment/disposal facilities.

Incidental amounts of soil cuttings generated during installation of extraction and monitoring wells and of groundwater generated during groundwater monitoring would be managed in accordance with State and federal regulations. They would be loaded into suitable containers and transferred to appropriate off-site treatment/disposal facilities.

Equipment used on site during implementation of this alternative may come in contact with potentially hazardous chemicals (contaminated groundwater). The equipment would be decontaminated prior to leaving the site. Decontamination water would be collected, sampled, and if required, properly treated and disposed.

5.4.3.5 Other Factors

<u>Long-Term Reliability and Effectiveness</u>

Alternative OSAGP3 would provide good long-term effectiveness because groundwater extraction would be very effective at containing contaminated groundwater. Long-term groundwater monitoring would be conducted to determine the effectiveness of this alternative.

Contaminant concentrations in groundwater commonly level off at concentrations greater than PRGs during implementation of groundwater extraction alternatives. If this occurs, the alternative would continue to be effective for containment, but it would not be effective for contaminant reduction. If containment is no longer a concern, the system can be shut down and the alternative switched to natural attenuation.

Groundwater extraction and treatment systems require periodic maintenance of mechanical components. Components susceptible to failure include wells (clogged screens due to iron scaling or fine-grained material), pumps, and electrical components. Proper operation and maintenance of the system would be required to maintain its reliability and effectiveness.

The effectiveness of the groundwater treatment system would be monitored through confirmation sampling of the treated effluent and gas emissions of the air stripper. The effectiveness of the treatment of the treatment system residuals would be confirmed by sampling and testing before the material is shipped off site for treatment/disposal.

During the installation and monitoring of the system, PPE would be used and monitoring conducted to ensure that exposure of workers to potentially contaminated material is minimized.

Reduction in Toxicity, Mobility, and Volume

Alternative OSAGP3 would utilize treatment of contaminated groundwater to reduce the toxicity, mobility, and volume of the waste. The toxicity of the VOCs and SVOCs would be eliminated through photochemical degradation in the atmosphere, thermal destruction during regeneration of activated carbon, if required, and/or natural in-situ biodegradation. The treatment residuals would be transported off site to a permitted treatment/disposal facility.

Short-Term Effectiveness

Alternative OSAGP3 would be effective in the short term by following safe work practices. The contaminant concentrations within the groundwater of the On-Site Southern Area Plume are expected to be relatively low, and exposure to groundwater by site workers would be managed by appropriate health and safety practices and PPE during implementation. If air stripping is used to treat the groundwater, the offgas would be treated as required to comply with State requirements. One potential risk to the community would be during transport of the contaminated treatment residuals off site for treatment and disposal. Because the residues to be collected are not anticipated to be hazardous, this risk is anticipated to be minimal.

Implementability

Alternative OSAGP3 is considered to be implementable. Drilling contractors and equipment are readily available for extraction well installation, and treatment equipment is also readily available for ex-situ treatment of the groundwater. The remedial technologies are well proven and established in the remediation and construction industries. Groundwater extraction and treatment systems would require operations and maintenance. Contractors and equipment are available to conduct operations and maintenance. Treatment/disposal facilities are available for the treatment system residuals. Sampling and analysis are also readily implementable.

Cost Analysis

The following costs are estimated for Alternative OSAGP3:

Capital Costs:	$1,786,000
O&M Costs:	$154,600 per year (Year 1)
	$143,500 per year (Year 2 through Year 11)
Monitoring Costs:	$60,900 per year (Year 1)
	$23,500 per year (Year 2 through Year 11)
	$23,000 per year (every 5 years)
30-Year Present Worth:	$3,111,000

Detailed cost estimates are provided in Appendix D.

5.4.4 Alternative OSAGP4: Institutional Controls/Deed Notifications, In-Situ Biological Treatment (Biobarrier with HRC®), Natural Attenuation, and Monitoring

Alternative OSAGP4 was developed as a passive in-situ bioremediation alternative. This alternative consists of implementing land use controls/deed notifications, creating and maintaining an HRC® barrier to biologically treat the COCs prior to off-site migration, and conducting groundwater monitoring.

5.4.4.1 Protection of Human Health and the Environment

Alternative OSAGP4 would be protective of human health and the environment by treating groundwater in the On-Site Southern Area Plume prior to off-site migration. HRC® assisted bioremediation would degrade the majority of contaminants in the groundwater. Groundwater monitoring would be conducted to determine the effectiveness of the alternative and whether additional action for groundwater would be necessary. Controls would be implemented to ensure contaminated groundwater would not be extracted or used for drinking until groundwater concentrations were less than PRGs.

5.4.4.2 Media Clean-Up Standards

Alternative OSAGP4 would eventually comply with most groundwater PRGs. The use of HRC® would address most contaminants in groundwater, especially the chlorinated solvents. Natural attenuation processes would ultimately reduce the remaining contaminant concentrations to the PRGs. Monitoring would be conducted to determine contaminant concentration trends. Land use controls/deed notifications would be used to prevent exposure to groundwater with contaminant concentrations greater than PRGs.

5.4.4.3 Source Control

This alternative would use HRC®-assisted bioremediation to contain and treat in situ the groundwater with contaminant concentrations in excess of PRGs. This action would reduce the potential for further migration of contaminated groundwater that could pose a threat to human health. The major historic source of contamination to the On-Site Southern Area Plume (i.e., discharges of contaminated groundwater from the former free product recovery system to drainage swales, overland transport, and reinfiltration) has been eliminated. If left uncontrolled, the contaminant sources at Sites 6A and 10B (contaminated soil/free product) would continue to contribute contamination to the groundwater at each site. It was assumed for this alternative that a majority of both sources would be addressed by one of the soil alternatives and that any residual impact from these sources would be addressed by this alternative. The fuel calibration and engine testing previously conducted at Sites 6A and 10B are no longer conducted; therefore, no additional contaminant releases should occur at these sites.

5.4.4.4 Waste Management Standards

During implementation of Alternative OSAGP4, contaminated groundwater would be contained and treated in situ using HRC®-assisted bioremediation and natural attenuation processes, and minimal waste would be generated that would require off-site treatment and disposal. Waste management practices would be used during implementation of the alternative to avoid spreading contamination. Minor amounts of drill cuttings and purge water would be generated during monitoring well installation and monitoring. These wastes would be loaded into suitable containers for transportation to an off-site treatment/disposal facility.

Equipment used on site may come in contact with potentially hazardous chemicals (contaminated groundwater and soil). The equipment would be decontaminated prior to leaving the site. Decontamination water would be collected, sampled, and if required, properly treated and disposed.

5.4.4.5 Other Factors

<u>Long-Term Reliability and Effectiveness</u>

Alternative OSAGP4 is expected to provide reasonable long-term effectiveness since HRC®-assisted bioremediation is expected to be very effective at treating solvent-contaminated groundwater, and natural attenuation can be effective for treating both fuel- and solvent-contaminated groundwater. Long-term groundwater monitoring would be conducted to determine the effectiveness of this alternative.

Contaminant concentrations in groundwater commonly level off at concentrations greater than PRGs during implementation of in-situ groundwater treatment alternatives. This alternative includes implementation of natural attenuation as well as an HRC® barrier to complete groundwater remediation to the PRGs.

During each installation of the HRC® barrier and groundwater monitoring, PPE would be used and monitoring conducted to ensure that exposure of workers to potentially contaminated material is minimized.

Reduction in Toxicity, Mobility, and Volume

Alternative OSAGP4 would utilize treatment of contaminated groundwater by in-situ bioremediation to reduce the toxicity, mobility, and volume of the waste. The treatment process would convert hazardous contaminants to nonhazardous or less toxic compounds that are more stable, less mobile, and/or inert.

Short-Term Effectiveness

Alternative OSAGP4 would be effective in the short term by following safe work practices. Site workers would receive the appropriate health and safety training and would wear the required PPE during implementation. HRC® is a nonhazardous product. The minor amounts of contaminated material generated during groundwater monitoring for this alternative should have no significant impact to the community during transportation off site for treatment/disposal. There are no potential environmental impacts from the implementation of this alternative. The potential human exposure to contaminated groundwater would be reduced through implementation of this alternative.

Implementability

Alternative OSAGP4 is considered to be implementable. It involves biostimulation/bioremediation with HRC®, which is considered an innovative technology, and natural attenuation. Contractors and equipment are available for injection of the HRC® and installation of additional wells. The remedial technologies of HRC® and natural attenuation have been the subject of studies that have established them as viable for fuel- and solvent-contaminated groundwater. Sampling and analysis are also readily implementable.

Cost Analysis

The following costs are estimated for Alternative OSAGP4:

Capital Costs:	\$2,563,000 (Year 0)
	\$2,064,000 per year (Years 1 through 10)
O&M Costs:	\$0
Monitoring Costs:	\$60,900 per year (Year 1)
	\$23,500 per year (Years 2 through 10)
	\$23,000 per year (every 5 years)
30-year Present Worth:	\$17,290,000

Detailed cost estimates are provided in Appendix D.

5.5 JUSTIFICATION

5.5.1 <u>Technical</u>

5.5.1.1 Sites 6A and 10B Soil

Because no actions would occur under Alternative S1, there would be no technical issues associated with implementation of the alternative. Alternatives S2, S5, and S6 would require long-term maintenance and restrictions in the transfer documents. Alternatives S3, S4, and S7 would not require long-term maintenance or land use restrictions because off-site treatment/disposal and/or on-site treatment would be used to address the contaminated soil and free-product. Alternatives S4, S5, and S7 would actively treat the contaminants in the soil on site and reduce the need for off-site treatment and disposal. Alternatives S3 and S4 would remediate the contaminated soil and free product in less than 1 year. Alternative S7 would remediate the contaminated soil and free product in approximately 2 years. Alternative S5 would be expected to address the VOC and SVOC contamination in the soil within 4 years; however, PCB contamination would remain in the soil for more than 30 years. Clean-up under Alternatives S2 and S6 would take more than 30 years, and the contaminated soil and free product would continue to act as a source of contamination to groundwater. Alternatives S2, S5, and S6 would include operation and maintenance and/or monitoring requirements. Alternatives S2 and S5 address PCB-contaminated soil through land use controls/deed notifications and Alternatives S6 and S7 would address the PCB-contaminated soil by excavation and off-site treatment/disposal. All seven alternatives are implementable.

5.5.1.2 Sites 6A and 10B Groundwater

No actions would occur under Alternative SAGW1; therefore, there would be no technical issues associated with implementation of the alternative. All of the alternatives, excluding Alternative SAGW1, would include monitoring requirements and land use controls/deed notifications in transfer documents until groundwater PRGs are met. Alternatives SAGW3, SAGW4, and SAGW5 would actively treat the contaminants in the groundwater. Alternatives SAGW3 and SAGW4 would include operation and maintenance during their implementation. Alternative SAGW3 would contain the contaminant plumes and prevent further downgradient migration. Alternative SAGW4 would need to be implemented with Alternative S5 to address the contaminated air created by the air sparging systems. Alternatives SAGW2 and SAGW3 would remediate all of the contaminated groundwater in approximately 30 years. Alternative SAGW3 would address VOCs in groundwater within a shorter period of time (approximately 10 years). Alternative SAGW5, which involves bioremediation and natural attenuation, would require approximately 6 years to address groundwater contamination at both sites. Alternative SAGW4 would be expected to address VOC and a majority of the SVOC contamination in groundwater within 4 years. All five alternatives are implementable.

5.5.1.3 On-Site Southern Area Plume Groundwater

No actions would occur under Alternative OSAGP1; therefore, there would be no technical issues associated with implementation of the alternative. All of the alternatives, excluding Alternative OSAGP1, would include monitoring requirements and land use controls/deed notifications in transfer documents until groundwater PRGs are met. Alternative OSAGP2 would passively address groundwater contamination with natural attenuation and controls. Alternatives OSAGP3 and OSAGP4 would contain the groundwater plume and prevent off-site migration. Both alternatives would also provide treatment of contaminants in the groundwater. Alternatives OSAGP3 and OSAGP4 would include operation and maintenance during their implementation. Alternative OSAGP2 would remediate all of the contaminated groundwater in approximately 30 years. Alternatives OSAGP3 and OSAGP4 would both address the contaminated groundwater within a shorter period of time (approximately 11 years). All four alternatives are implementable.

5.5.2 <u>Human Health</u>

5.5.2.1 Sites 6A and 10B Soil

Contaminated soil is present at depth at both sites, and as long as it remains at depth, it should not present a direct contact risk to the environment. Alternative S1 would not be protective of human health because of the lack of controls and the potential for continued contaminant migration to groundwater. Risks from direct contact with contaminated soil would be addressed by implementing land use controls/deed notifications in transfer documents in Alternatives S2, S5, and S6. Alternative S6 would address PCB-contaminated soil by off-site treatment/disposal. Alternative S3 would address the contaminated soil by off-site treatment/disposal at an approved facility. Alternative S4 provides for on-site treatment of the contaminated soil. Alternative S5 would also provide on-site treatment of the contaminated soil, but the treatment process (SVE) would not be effective on PCBs in soil at Site 6A.

Alternative S7 includes a combination of off-site and on-site treatment/disposal. The free product recovered under Alternatives S3, S4, S6, and S7 would be treated/disposed off site at an approved facility. Alternatives S3, S4, S5, and S7 would minimize the migration of soil contaminants to groundwater. Contaminants remaining in the soil at concentrations greater than PRGs under Alternatives S1, S2, and S6 would continue to act as a source of contamination to groundwater. Alternatives S3, S4, and S7 would be equally protective of human health, although Alternatives S4 and S7 would also reduce the toxicity, mobility, and volume of contamination by treatment. Alternatives S5 and S6 would be less protective than Alternatives S3, S4, and S7. Alternative S2 would be the least protective alternative other than Alternative S1.

5.5.2.2 Sites 6A and 10B Groundwater

Even though there are no current users of groundwater for potable water, Alternative SAGW1 would not be protective of human health because of the lack of controls on potential future groundwater use and the potential for continued contaminant migration. Immediate risks from direct contact with contaminated groundwater would be addressed by implementing land use controls/deed notifications in transfer documents for Alternatives SAGW2, SAGW3, SAGW4, and SAGW5. Alternative SAGW2 would allow natural attenuation to slowly remediate groundwater contamination and ultimately protect human health. Alternatives SAGW3, SAGW4, and SAGW5 would actively treat the contaminated groundwater to protect human health. Alternative SAGW3 would be the most protective alternative, followed by Alternatives SAGW4 and SAGW5. Alternative SAGW2 would be the least protective alternative other than Alternative SAGW1.

5.5.2.3 On-Site Southern Area Plume Groundwater

Alternative OSAGP1 would not be protective of human health because even though there are no current users of groundwater for potable water, the alternative does not include controls on potential future groundwater use or reduce the potential for contaminant migration. Immediate risks from direct contact with contaminated groundwater would be addressed by implementing land use controls/deed notifications in transfer documents for Alternatives OSAGP2, OSAGP3, and OSAGP4. Alternative OSAGP2 would allow natural attenuation to slowly remediate groundwater contamination and ultimately protect human health. Alternatives OSAGP3 and OSAGP4 would contain and ultimately treat the contaminated groundwater to protect human health. Alternatives OSAGP3 and OSAGP4 would be equally protective followed by Alternative OSAGP2.

5.5.3 Environmental

5.5.3.1 Sites 6A and 10B Soil

None of the alternatives would adversely affect the environment. Contaminated soil is present at depth at both sites, and as long as it remains at depth, it should not present a direct contact risk to environmental receptors. Alternatives S3, S4, S5, and S7 would minimize the migration of contaminants from soil to groundwater and any downgradient impacts to the environment. Contaminants remaining in the soil at concentrations greater than PRGs under Alternatives S1, S2, and S6 would continue to be a source of groundwater contamination and potentially impact downgradient environmental receptors.

5.5.3.2 Sites 6A and 10B Groundwater

None of the alternatives would adversely affect the environment. Alternatives SAGW3, SAGW4, and SAGW5 would minimize the migration of contaminated groundwater off site and the impacts to downgradient environmental receptors. Alternatives SAGW1 and SAGW2 would allow contaminant concentrations in groundwater to remain greater than PRGs longer than the other alternatives, resulting in an increased potential for off-site migration and impact to downgradient environmental receptors.

5.5.3.3 On-Site Southern Area Plume Groundwater

None of the alternatives would adversely affect the environment. Alternatives OSAGP3 and OSAGP4 would minimize the migration of contaminated groundwater off site and the impacts to downgradient environmental receptors. Alternatives OSAGP1 and OSAGP2 would allow contaminant concentrations in groundwater to remain greater than PRGs longer than the other alternatives, resulting in an increased potential for off-site migration and impact to downgradient environmental receptors.

5.5.4 Cost Estimates

The estimated capital, O&M, and net present worth costs of all soil and groundwater alternatives are presented in Table 5-1.

5.6 RECOMMENDED CORRECTIVE MEASURE

The section provides the recommended alternatives for Site 6A and Site 10B soil and groundwater, and the onsite portion of the Southern Area groundwater.

5.6.1 Site 6A and 10B Soil

The recommended remedial action for the soil at Sites 6A and 10B is Alternative S3 - Excavation and Off-Site Treatment and Disposal. This alternative includes the excavation of approximately 14,000 cubic yards of material at Sites 6A and 10B. Of this volume, approximately 3,900 cubic yards of petroleum-, solvent-, and/or PCB-contaminated material would be sent off-site for treatment and/or disposal. The remaining soil would be evaluated on site for the presence of residual contamination, and if determined acceptable, used as on-site backfill material. The cost for this alternative is estimated to be $3,710,000 with no additional annual costs.

This alternative would remove more than 90% of the petroleum-contaminated soil and all of the PCB-contaminated soil. The residual petroleum contamination is below the water table and cannot be effectively excavated. The remedy can be completed in approximately 1 to 2 years after selection of the remedy. Once the alternative is implemented, the remaining contamination in the source area soil should naturally attenuate.

5.6.2 Sites 6A and 10B Groundwater

The recommended remedial action for the on-site groundwater at Sites 6A and 10B is Alternative SAGW2 – Land Use Controls/Deed Notifications, Natural Attenuation, and Monitoring. This alternative includes implementation of land use controls. deed notifications, and annual groundwater monitoring.

The estimated capital cost for this alternative is $181,000 to establish land use controls, deed notifications, and to install monitoring wells. Depending on the year, annual costs would range from $20,900 to $69,700. Once the source areas are removed, residual groundwater contamination is expected to attenuate within approximately 10 to 16 years.

5.6.3 On-Site Southern Area Plume Groundwater

The recommended remedial action for the Southern Area on-site groundwater plume is Alternative OSAGP2 – Land Use Controls/Deed Notifications, Natural Attenuation, and Monitoring. This alternative includes implementation of land use controls, deed notifications, and groundwater monitoring. The capital cost for this alternative is estimated to be $108,000. Depending on the year, annual costs would range from $20,900 to $69,700. There are no down gradient receptors that would be adversely impacted by the contaminated groundwater. The down gradient property is owned by New York State (for conservation) and a local sportsman club. The Peconic River is the ultimate discharge point of the groundwater, and based on the concentrations detected in the groundwater and appropriate criteria for the river, adverse impacts to the river are not anticipated. The chemicals of concern in the groundwater (VOCs) are relatively non-toxic to aquatic receptors and are not persistent in surface water. In the absence of a continuing source of groundwater contamination (Sites 6A and 10B contaminated soil), the On-site Southern Area Plume Groundwater is expected to attenuate naturally at about the same rate as the residual soil contamination (approximately 10 to 16 years).

TABLE 5-1

SUMMARY OF CAPITAL, ANNUAL, O&M, AND PRESENT WORTH COSTS ESTIMATES
SITE 6A - FUEL CALIBRATION AREA, SITE 10B - ENGINE TEST HOUSE AND ON-SITE SOUTHERN AREA PLUME
NWIRP CALVERTON, NEW YORK

Alternative	Capital Cost	Annual Cost	O&M	Net Present Worth
SITE 6A AND 10B SOIL				
S1 - No Action	$0	---	---	$0
S2 - Land Use Controls/Deed Notifications and Monitoring	$227,000	Annually $1,000 Every 5 Years $36,000	---	$317,000
S3 - Excavation and Off-Site Treatment and Disposal	$3,710,000	---	---	$3,710,000
S4 - Excavation, On-Site Treatment (Thermal), and On-Site Re-Use	$5,114,000	---	---	$5,114,000
S5 - Institutional Controls/Deed Notifications, In-Situ Treatment (Soil Vapor Extraction), and Monitoring	$2,370,000	Annually $1,000 Years 1-4 $30,000 Every 5 Years $30,000	Year 1 $210,000 Year 2 $169,000 Year 3 $169,000 Year 4 $169,000	$3,155,000
S6 - Land Use Controls/Deed Notifications, Monitoring, and Excavation of PCB-Contaminated Hot Spots and Off-Site Treatment and Disposal	$540,000	Annually $1,000 Every 5 Years $35,000	---	$627,000
S7 - Excavation of PCB-Contaminated Hot Spots and Off-Site Treatment/Disposal and In-Situ Treatment of Petroleum- and Solvent-Contaminated Soil by ISCO	$32,217,000	---	---	$32,217,000

TABLE 5-1

SUMMARY OF CAPITAL, ANNUAL, O&M, AND PRESENT WORTH COSTS ESTIMATES
SITE 6A - FUEL CALIBRATION AREA, SITE 10B - ENGINE TEST HOUSE AND ON-SITE SOUTHERN AREA PLUME
NWIRP CALVERTON, NEW YORK

Alternative	Capital Cost	Annual Cost	O&M	Net Present Worth
SITE 6A AND 10B GROUNDWATER				
SAGW1 - No Action	$0	$0	$0	$0
SAGW2 - Land Use Controls/Deed Notifications, Natural Attenuation, and Monitoring	$181,000	Year 1 $69,700 Years 2 – 10 $25,700 Years 11 – 30 $20,900 Every 5 Years $23,000	---	$564,000
SAGW3 - Land Use Controls/Deed Notifications, Groundwater Extraction (Wells), Treatment (Air Stripping/Activated Carbon), Re-Injection (Infiltration Galleries), and Monitoring	$1,653,000	Year 1 $69,700 Years 2 – 9 $25,700 Years 10 – 30 $20,900 Every 5 Years $23,000	Year 1 $177,000 Years 2 – 9 $164,000 Year 10 – 30 $98,000	$3,692,000
SAGW4 - Land Use Controls/Deed Notifications, In-Situ Treatment (Air Sparging), and Monitoring	$967,000	Year 1 $69,700 Years 2 – 4 $25,700	Annually $118,600	$1,497,000
SAGW5 - Land Use Controls/Deed Notifications, In-Situ Biological Treatment (Biostimulation with HRC and ORC), Natural Attenuation, and Monitoring	$1,899,000	Years 1 – 3 $59,700 Years 4 – 6 $15,700 Every 5 Years $23,000	---	$2,105,000

TABLE 5-1

SUMMARY OF CAPITAL, ANNUAL, O&M, AND PRESENT WORTH COSTS ESTIMATES
SITE 6A - FUEL CALIBRATION AREA, SITE 10B - ENGINE TEST HOUSE AND ON-SITE SOUTHERN AREA PLUME
NWIRP CALVERTON, NEW YORK

Alternative	Capital Cost	Annual Cost	O&M	Net Present Worth
ON-SITE SOUTHERN AREA PLUME				
OSAGP1 - No Action	$0	$0	$0	$0
OSAGP2 - Land Use Controls/Deed Notifications, Natural Attenuation, and Monitoring	$108,000	Year 1 $60,900 Years 2 – 30 $23,500 Every 5 Years $23,000	---	$484,000
OSAGP3 - Land Use Controls/Deed Notifications, Groundwater Extraction (Wells), Treatment (Air Stripping/Activated Carbon), Re-Injection (Infiltration Galleries), and Monitoring	$1,786,000	Year 1 $60,900 Years 2 – 11 $23,500 Every 5 Years $23,000	Year 1 $154,600 Years 2 – 11 $143,500	$3,111,000
OSAGP4 - Land Use Controls/Deed Notifications, In-Situ Biological Treatment (Biobarrier with HRC), Natural Attenuation, and Monitoring	Year 0 $2,563,000 Years 1 – 10 $2,064,000	Year 1 $60,900 Years 2 – 10 $23,500 Every 5 Years $23,000	---	$17,290,000

REFERENCES

ATSDR (Agency for Toxic Substances and Disease Registry), 1989. Toxicological Profile for Xylene. U.S. Department of Public Health, Atlanta, Georgia, October.

ATSDR, 1997. ATSDR Toxicological Profiles on CD-ROM. U.S. Department of Public Health, Atlanta, Georgia.

C.F. Braun (C.F. Braun Engineering Corporation), 1997. RCRA Facility Assessment - Sampling Visit Addendum, NWIRP Calverton, New York, CLEAN Program, Prepared by C.F. Braun Engineering Corporation, Contract Number N62472-90-D-1298, CTO 0138, January.

C.F. Braun, 1998. Draft Phase 2 RCRA Facility Investigation for Sites 6A, 10A, 10B, and the Southern Area, NWIRP Calverton, New York, CLEAN Program, Prepared by C.F. Braun Engineering Corporation, Contract Number N62472-90-D-1298, CTO 0270, January.

Dragun, 1988. The Soil Chemistry of Hazardous Materials. Hazardous Material Controls Research Institute, Silver Spring, Maryland.

EPA (United States Environmental Protection Agency), 1982. Aquatic Fate Process Data for Organic Priority Pollutants. December.

EPA, 1992. Handbook of RCRA Groundwater Monitoring Constituents: Chemical and Physical Properties (Appendix IX to 40 CFR Part 264). Office of Solid Waste, EPA/530/R-92/022. September.

EPA, 1996. Soil Screening Guidance: Technical Background Document. EPA/540/R-95/128, Office of Solid Waste and Emergency Response, Washington, D.C., May.

Feenstra S., J.A. Cherry, and B.L. Parker, 1995. Dense Chlorinated Solvents in Groundwater: Background History of the Problem.

Fetter, C.W., Jr., 1976. Hydrogeology of the South Fork of Long Island, New York, Bulletin, Geological Society of America, Volume 87, pp. 401-406.

Ford and Gurba, 1984. Methods of Determining Relative Contaminant Mobilities and Migration Pathways Using Physical-Chemical Data.

HNUS (Halliburton NUS, Inc.), 1992. Final Site Investigation, NWIRP Calverton, New York, CLEAN Program, Prepared by HNUS, Contract Number N62472-90-D-1298, CTO 0002, April.

HNUS, 1995a. RCRA Facility Investigation, NWIRP, Calverton, New York, CLEAN Program, Prepared by HNUS, Contract Number N62472-90-D-1298, CTO 0138, August.

HNUS, 1995b. RCRA Facility Investigation Addendum, NWIRP, Calverton, New York, CLEAN Program, Prepared by HNUS, Contract Number N62472-90-D-1298, CTO 0138, September.

Howard, P.H., 1989. Handbook of Environmental Fate and Exposure Data for Organic Chemicals, Volume 1. Large Production and Priority Pollutants. Lewis Publishers, Chelsea, MI.

Isbister, J., 1966. "Geology and Hydrology of Northeastern Nassau County, Long Island, New York, Water Supply Paper 1825, U.S. Geological Survey.

Laskowski, D.A., C.A. Goring, P.S. McCall, and R.L. Swann, 1983. Environmental Risk Analysis for Chemicals. Van Nostrand Reinhold Company, New York, New York.

Lyman, W.J., W.F. Reehl, and D.H. Rosenblatt, 1990. Handbook of Chemical Property Estimation Methods. American Chemical Society. Washington, D.C.

McClymonds, N., and O. Franke, 1972. "Water Transmitting properties of Aquifers on Long Island, New York." U.S. Geological Survey Professional Paper 627-E.

Navy, 1986. Initial Assessment Study of NWIRP Bethpage, NY and NWIRP Calverton, NY, NEESA 13-100, Contract Number N62474-84-3386, Environmental Restoration Department, Naval Energy and Environmental Support Activity Rogers, Golden & Halpern, Philadelphia, PA, December.

NOAA (National Oceanic and Atmospheric Administration), 1982. No. 81, Climatography of the United States, "Monthly Normals of Temperature, Precipitation, and heating and Cooling Degree Days, 1951-1980", New York, September.

Seaburn, G.E., 1970. "Preliminary Analysis of Rate of Movement of Storm Runoff Through the Zone of Aeration Beneath a Recharge Basin on Long Island, New York." Professional Paper 700-B, U.S. Geological Survey, pp. 196-198.

TAGM. Technical and Administrative Guidance Memorandum on Determination of Soil Cleanup Objectives and Cleanup Levels, Number 4046, New York State Department of Environmental Conservation, January 24, 1994 Revision.

TtNUS (Tetra Tech NUS, Inc.), 1998. Engineering Evaluation/Cost Analysis for Sites 2, 6A, 7, and 10B, NWIRP, Calverton, New York, CLEAN Program. Contract Number N62472-90-D-1298, CTO 0270, September.

TtNUS, 2001. Phase 2 Remedial Investigation for Site 6A - Fuel Calibration Area, Site 10B – Engine Test House, and Southern Area, NWIRP, Calverton, New York, CLEAN Program. Contract Number N62472-90-D-1298, CTO 0223, July.

TtNUS, 2004. Work Plan for Site 6A - Fuel Calibration Area and Southern Area Supplemental Investigation, NWIRP, Calverton, New York, CLEAN Program. Contract Number N62472-03-D-0057, CTO 0004, September.

TtNUS, 2005. Data Summary Report for Site 6A - Fuel Calibration Area and Southern Area, NWIRP, Calverton, New York, CLEAN Program. Contract Number N62472-03-D-0057, CTO 0004, September.

USGS (United States Geologic Survey), 1967. Wading River, New York, quadrangle, 7.5 minute series. Topographic Map; combined with Riverhead, New York quadrangle, 7.5 minute series, Topographic Map, 1956 and Moriche, New York quadrangle, 7.5 minute series. Topographic Map, 1967 and Eastport, New York, 7.5 minute series, Topographic Map, 1956 and Bellport, New York quadrangle, 7.5 minute series, Topographic Map, 1967 and Middle Island, New York, 7.5 minute series, Topographic Map, 1967.

United States Department of Commerce, 1961. Weather Bureau Technical paper No. 40. Rainfall Frequency Atlas of the United States.

APPENDIX A

JANUARY 2006 SITE 6A DATA GAP INVESTIGATION

January 2006, Site 6A
Data Gap Investigation

Naval Weapons
Industrial Reserve Plant

Calverton, New York

Engineering Field Activity Northeast
Naval Facilities Engineering Command

Contract Number N62472-03-D-0057

Contract Task Order 004

May 2006

100508/P

JANUARY 2006, SITE 6A
DATA GAP INVESTIGATION

NAVAL WEAPONS INDUSTRIAL RESERVE PLANT
CALVERTON, NEW YORK

COMPREHENSIVE LONG-TERM
ENVIRONMENTAL ACTION NAVY (CLEAN) CONTRACT

Submitted to:
Engineering Field Activity Northeast
Environmental Branch Code EV2
Naval Facilities Engineering Command
10 Industrial Highway, Mail Stop #82
Lester, Pennsylvania 19113-2090

Submitted by:
Tetra Tech NUS, Inc.
600 Clark Avenue, Suite 3
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CONTRACT NUMBER N62472-03-D-0057
CONTRACT TASK ORDER 004

MAY 2006

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1.0 INTRODUCTION

1.1 PURPOSE

The purpose of this report is to document the field activities and present the findings of surface and subsurface soil sampling performed during the month of January 2006 at Site 6A – Fuel Calibration Area at the Naval Weapons Industrial Reserve Plant (NWIRP) in Calverton, New York. This report was prepared by Tetra Tech NUS, Inc. (TtNUS) under the Comprehensive Long-Term Environmental Action Navy (CLEAN) Contract N62472-03-D-0057, Contract Task Order (CTO) 004.

The activities and sampling summarized in this report were performed under the Navy's Installation Restoration (IR) Program, which was designed to identify contamination of Navy and Marine Corps lands and facilities resulting from past operations and to institute remedial actions as necessary. The IR Program consists of four distinct stages. Stage 1 is the Preliminary Assessment (PA), which was formerly known as the Initial Assessment Study (IAS). Stage 2 is a Resource Conservation and Recovery Act (RCRA) Facility Assessment-Sampling Visit, also referred to as a Site Investigation (SI), which augments information collected in the PA. Stage 3 is the RCRA Facility Investigation (RFI) and Corrective Measures Study (CMS), also referred to as a Remedial Investigation (RI) and Feasibility Study (FS) or Focused Feasibility Study (FFS), that characterizes site contamination and develops options for remediation of the site. Stage 4 is the Corrective Action, also referred to as the Remedial Action, which results in the control or cleanup of contamination at a site. This data summary report summarizes the field activities and associated testing results conducted at Site 6A in January 2006. This report has been prepared in support of the Feasibility Study/Corrective measurement Study (FS/CMS) (Stage 3 of the Navy's IR Program).

The field activities and sampling procedures performed at Site 6A in January 2006 were conducted in accordance with the requirements of the New York State Department of Environmental Conservation (NYSDEC) Division of Solid & Hazardous Materials Part 373 Permit issued to the Navy on April 18, 2000 under the NYSDEC implementing regulations [6 New York Codes, Rules, and Regulations (NYCRR) Part 621]. This permit supersedes and replaces the original Part 373 Permit to Operate a Hazardous Waste Storage Facility issued to what was then Grumman Aerospace Corporation on March 25, 1992. The new permit, issued only to the Department of the Navy, deals exclusively with those Solid Waste Management Units (SWMUs) that remain on the former NWIRP Calverton property and any Corrective Actions that may be required to adequately address each of these SWMUs.

Site 6A is listed as Classification 2 in the NYSDEC Registry of Inactive Waste Disposal Sites.

1.2 OBJECTIVE AND SCOPE

The objective of this investigation was to fill data gaps with regard to petroleum-contaminated soil and polychlorinated biphenyls (PCB)-contaminated soil identified during previous investigations. Historically, free product and petroleum-contaminated groundwater and soil have been identified at Site 6A, but the northern extent of the petroleum-contaminated soil has not been well defined. In addition, samples collected from monitoring well 4/CG during the 1998 Engineering Evaluation/Cost Analysis (EE/CA), indicated the presence of PCB contamination in the floating free product on the groundwater, but the presence or extent of PCB-contaminated soil at this location has not been well defined. Filling these data gaps will define the horizontal and vertical extent of petroleum-contaminated and PCB-contaminated soils. Therefore, the objectives of the Site 6A January 2006 field investigation were as follows;

1. To determine the horizontal and vertical extent of petroleum-contaminated soil in the area northwest of the concrete pad (former transformer location) and monitoring well 4/CG.

2. To verify the presence and horizontal/vertical extent (if present) of PCB-contaminated soil in the area of the concrete pad (former transformer location) and monitoring well 4/CG.

1.3 FACILITY LOCATION

NWIRP Calverton is located in Suffolk County, Long Island, New York, approximately 70 miles east of New York City. The facility is located within the Town of Riverhead and includes approximately 358 acres of the original 6,000-acre facility (refer to Figure 1-1 of the FS/CMS).

1.4 ACTIVITY BACKGROUND INFORMATION

1.4.1 Facility Layout

The facility is bordered by Middle Country Road (Route 25) to the north, agricultural land to the east, River Road to the south, and Wading River Road to the west. The primary features of the facility were two paved runways. Runway 5-23 was located on the western half of the facility and oriented southwest to northeast. Runway 32-14 was located on the eastern half of the facility and oriented southeast to northwest.

NWIRP Calverton consists of five separate parcels of land totaling approximately 358 acres. Eight Navy IR sites are included within these parcels as follows:

Parcel A (32 acres)

Site 2 - Fire Training Area

<u>Parcel B1 (40 acres)</u>

Site 6A - Fuel Calibration Area

Site 10B - Engine Test House

<u>Parcel B2 (131 acres)</u>

Southern Area

<u>Parcel C (10 acres)</u>

Site 7 - Fuel Depot

Site 10A - Jet Fuel Systems Laboratory

<u>Parcel D (145 acres)</u>

Site 1 - Northeast Pond Disposal Area

Site 9 - Electronic Counter Measures (ECM) Area

1.4.2 Facility History

NWIRP Calverton has been owned by the United States Navy since the early 1950s. At that time, the property was purchased from a number of private owners. The facility was expanded in 1958 through additional purchases of privately owned land. Northrop Grumman Corporation (previously Grumman Corporation) operated the facility since its construction to 1996.

NWIRP Calverton was constructed in the early 1950s for use in the development, assembly, testing, refitting, and retrofitting of Naval combat aircraft. Northrop Grumman had been the sole operator of the facility, which is known as a Government-Owned-Contractor-Operated (GOCO) installation. The facility supported aircraft design and production at nearby NWIRP Bethpage, which was also operated by Northrup Grumman.

The majority of industrial activities at the facility were confined to the developed area in the central and south-central portions of the facility, between the two runways. Industrial activities at the facility were related to the manufacturing and assembly of aircraft and aircraft components. Hazardous waste generation at the facility was related to metal finishing processes such as metal cleaning and electroplating. The painting of aircraft and components resulted in additional waste generation.

Northrop Grumman operations at the facility ended in February 1996. In September 1998, the majority of the land within the developed section of the facility was transferred to the Town of Riverhead for redevelopment. Because of the need for additional environmental investigation and the potential need for remediation, the Navy retained parcels of land within the developed section. The parcels and associated Navy IR sites are presented on Figure 1-2 of the FS/CMS.

Approximately 3,000 acres of undeveloped land outside of the fenced areas, formerly associated with NWIRP Calverton, were transferred to the Veterans Administration and NYSDEC in 1999.

1.5 REPORT FORMAT

This report consists of four sections. Section 1 of this report presents this introduction. Section 2 describes the field tasks. Section 3 presents the field test kit and analytical results. Section 4 presents the investigation conclusions.

2.0 FIELD INVESTIGATION

The following sections describe the field procedures followed while performing the Site 6A – Fuel Calibration Area January 2006 investigation activities. These activities were performed in two areas within the Site 6A limits. The northern area, investigated to further define the horizontal and vertical extent of petroleum-contaminated soil, included the area to the northwest of the concrete pad (former electrical transformer location located adjacent to and northwest of monitoring well 4/CG. The southern area, investigated to verify the presence of PCB-contaminated soil and to determine the horizontal and vertical extent of PCB-contaminated soils (if present), included the area in the vicinity of monitoring well 4/CG and the adjacent concrete pad.

The activities performed during the January 2006 Site 6A Investigation included the following:

- Advancing soil borings using direct-push technology (DPT).
- Screening soil obtained using DPT with a photoionization detector (PID) and visual inspecting soil for free product.
- Collecting soil samples for PCB analysis with field test kits.
- Collecting soil samples for PCB analysis at a fixed-base laboratory to confirm field test kit results.

Table A-2-1 provides a summary of soil boring identification numbers, sample identification numbers, and analyses including quality assurance (QA) and quality control (QC) samples. Figure A-2-1 presents the investigation area and DPT boring locations. Soil boring logs are provided in Attachment A. Chain-of-custody forms are provided in Attachment B.

2.1 FIELD PROCEDURES

2.1.1 Horizontal and Vertical Extent of Petroleum-Contaminated Soil

The objective of this portion of the January 2006 investigation was to determine the horizontal and vertical extent of petroleum-contaminated soil northwest of the concrete pad adjacent to monitoring well 4/CG. The investigations activities in this area included continuous soil sampling using DPT. In accordance with the Sampling and Analysis Plan for Site 6A – Fuel Calibration Area two soil borings were installation in the area northwest of monitoring well 4/CG (FC-SB-110 and FC-SB-111). Following visual classification and PID measurements of the first two borings, six additional borings were installed in the area (FC-SB-112 and FC-SB-122 through FC-SB-126). In addition to these soil borings, the soil borings advanced to verify the presence of PCB contamination in the soil surrounding monitoring well 4/CG (see Section 2.1.2) were used as supplemental locations to further refine the extent of petroleum contamination in the soil within the vicinity of monitoring well 4/CG. These borings included soil borings FC-SB/SS-101 through FC-SB/SS-109 and FC-SB-113 through FC-SB-120. Table A-2-1 summarizes the soil boring locations included in the PID screening, and Figure A-2-1 identifies the soil boring locations.

The extent of petroleum-contaminated soil was determined by screening the soils removed from the identified soil boring locations with a PID and visually inspecting this soil for free product. A continuous column of soil was removed from each boring location (surface to a depth of 8 feet) using DPT macro cores (in 2-foot intervals). After the macro core was removed from the ground, the macro core sleeve was cut open and a PID was run over the surface of the exposed soil. The PID readings were then recorded on the soil boring logs at the corresponding boring depths. In addition to PID readings, the cores were also visually inspected for free product. If product was identified, its presence was noted on the boring logs at the appropriate depths. The extent of petroleum contamination was then determined based on the results of the PID screening results and visual free product inspection. The results of the PID screening and visual inspection and how they were used to identify the presence of petroleum contamination is discussed in Section 3 of this report.

The methods used to advance soil borings, screen soils, and abandon boring locations, followed the requirements set forth in the standard operation procedures (SOPs) presented in the Sampling and Analysis Plan.

2.1.2 PCB Soil Contamination Investigation

The objective of this portion of the January 2006 investigation was to verify the presence of PCB-contaminated soils in the vicinity of monitoring well 4/CG and the adjacent concrete pad and, if verified, determine the horizontal and vertical extent of the PCB-contaminated soil. The investigation activities in this area included continuous soil sampling using DPT. In accordance with the Sampling and Analysis Plan for Site 6A – Fuel Calibration Area nine soil borings were advanced in the vicinity of monitoring well 4/CG (FC-SB/SS-101 through FC-SB/SS-109). Following the collection of surface and subsurface soil samples from the initial nine soil boring locations, surface and subsurface soil samples were collected from one additional soil boring (FC-SB/SS-116), subsurface soil samples were collected from seven additional soil borings (FC-SB-113 through FC-SB-115 and FC-SB-117 through FC-SB-120), and surface soil samples were collected from three additional sampling locations (FC-SS-121, FC-SS-128, and FC-SS-129). Table A-2-1 summarizes the soil boring installation, and Figure A-2-1 identifies the soil boring locations.

The extent of PCB-contaminated soil was determined by sampling the soils removed from the identified soil boring locations with field test kits. The results obtained using the field test kits were then verified by sending a portion of the samples to a fixed-base laboratory. The soil samples were collected from a continuous column of soil removed from each boring location (surface to a depth of 8-feet) using DPT macro cores (in 2-foot intervals). After the macro core was removed from the ground, the macro core sleeve was cut open, a PID was run over the surface of the exposed soil, and the soil was inspected for free product. Soil samples were collected from 0 to 0.5 foot (surface soil sample) and 6 to 7 feet (subsurface soil sample at groundwater interface). When an intermittent sample was collected, the sample interval varied based on petroleum odor (assumed top of the smear zone) and/or visual properties of the soil (when petroleum odor was not detected). At some locations, surface and/or subsurface soil samples were not collected based on sampling results in neighboring borings and/or sampling results from the same boring. The results of the surface and subsurface soil sampling and how these results were used to identify the presence and extent of PCB contamination is discussed in Section 3 of this report.

As indicated above, to verify the test kit results, a select number of samples was sent to a fixed-base laboratory for analysis. Based on the results of the PCB test kits, 20 samples were sent to a fix based laboratory for PCB analysis. The samples sent for fixed-based laboratory analysis are identified below and are summarized in Table A-2-1:

- Three surface soil samples within the area of PCB contamination to verify the presence of PCBs in surface soil (FC-SS-102, FC-SS-104, and FC-SS-106).

- Three surface soil samples surrounding the area of PCB contamination to define the horizontal extent of surface soil PCB contamination (FC-SS-109, FC-SS-121, and FC-SS-128).

- Four subsurface soil samples within the area of PCB contamination to verify the presence of PCBs in subsurface soil (FC-SB-102-3545, FC-SB-104-0102, FC-SB-106-0203, and FC-SB-108-2535).

- Four subsurface soil samples below the area of PCB contamination to define the vertical extent of PCB contamination (FC-SB-102-0607, FC-SB-104-0607, FC-SB-106-0607, and FC-SB-108-0607).

- Six subsurface soil samples surrounding the area of PCB contamination to define the horizontal extent of subsurface soil PCB contamination (FC-SB-103-3545, FC-SB-113-3545, FC-SB-114-0102, FC-SB-114-0102, FC-SB-115-2535, FC-SB-117-0203, and FC-SB-119-3545).

The methods used to advance soil borings, screen soils, abandon boring locations, and collect soil samples followed the requirements set forth in the SOPs presented in the Sampling and Analysis Plan.

2.1.4 Decontamination Procedures

Down-hole sampling equipment (i.e., DPT rods) was decontaminated using a high-pressure steam wash prior to commencing drilling, between locations, and prior to leaving the site. All decontamination fluids were collected and stored in the existing holding tanks on site.

The methods used to perform the decontamination activities followed the requirements set forth in the SOPs presented in the Sampling and Analysis Plan.

2.1.5 Handling Investigation-Derived Waste

Personal protective equipment and other miscellaneous trash visibly free of soil was bagged and removed from the site by TtNUS for disposal as general refuse. Soil cuttings and decontamination fluid were drummed and staged for disposal characterization sampling at a location designated by the Navy.

The methods used to handle investigation-derived waste followed the requirements set forth in the SOPs presented in the Sampling and Analysis Plan.

2.2 SAMPLING AND ANALYSES

2.2.1 Sample Designation and Handling

Samples were assigned a unique sampling number consisting of up to four parts including the site identifier, sample type, boring number, and sample depth. An example sample number is provided below with explanation.

Site	Sample Number Designation
Site 6A – Fuel Calibration Area	FC
Sample Type	Sample Number Designation
Subsurface Soil	SB
Surface Soil	SS
Boring Number	Sample Number Designation
Number	101 – 129
Sample Depth	Sample Number Designation
2.5 to 3.5 feet below ground surface (bgs)	2535

As an example, sample FC-SB-102-3545 was collected from Site 6A – Fuel Calibration Area (FC), from boring location 102 (SB-102), at a depth of 3.5 to 4.5 feet bgs (3545).

QA samples (field blanks and field duplicates) were designated by medium and QA type with the date collected and numbered sequentially. As an example, DUP-012406-01 indicates a duplicate sample (DUP) collected on January 24, 2006 (012406), that was the first duplicate sample collected on that day (01).

The methods of assigning sample identification numbers followed the requirements set forth in the SOPs presented in the Sampling and Analysis Plan.

2.2.2 Quality Assurance/Quality Control

QA/QC included correct field equipment calibration and the collection of QA/QC samples. Equipment calibration included the daily calibration of PIDs. The PIDs were calibrated according to manufacturer's recommendations and at a frequency recommended by the manufacturer. QA/QC samples were collected at a rate of one duplicate sample for every 10 samples collected for laboratory analysis and one field blank sample for each week of sampling.

The methods used to assure QA/QC followed the requirements set forth in the SOPs presented in the Sampling and Analysis Plan.

2.2.3 Sample Analysis

The sample analyses were based on the past contaminant detections and anticipated future land use at Site 6A. Samples submitted to the laboratory for analysis were analyzed for PCBs. In addition to the soil samples collected, field blank and field duplicate samples were analyzed for the same parameter as the associated sample(s) for QC purposes. All of the fixed-base laboratory samples were analyzed by Severn Trent Laboratories Inc. located Pittsburgh, Pennsylvania. Each sample was analyzed with a 7-day turn-around time; however, the results were not considered final until the data were validated.

The methods used to analyze the fixed-base laboratory samples followed the requirements set forth in the SOPs presented in the Sampling and Analysis Plan.

TABLE A-2-1

SAMPLE IDENTIFICATION AND ANALYSIS SUMMARY
SITE 6A - FUEL CALIBRATION AREA
NWIRP CALVERTON, NEW YORK

Boring Number	Sample Identification	Visual	PID	PCB Test Kit (1)	Analytical Laboratory
Soil Boring Installation North of the Concrete Pad and Well 4/CG					
FC-SB-110	NA	X	X	--	--
FC-SB-111	NA	X	X	--	--
FC-SB-112	NA	X	X	--	--
FC-SB-122	NA	X	X	--	--
FC-SB-123	NA	X	X	--	--
FC-SB-124	NA	X	X	--	--
FC-SB-125	NA	X	X	--	--
FC-SB-126	NA	X	X	--	--
Surface Soil Collection at the Concrete Pad and Well 4/CG					
FC-SS-101	NA	X	X	X	--
FC-SS-102	FC-SS-102	X	X	X	X
FC-SS-103	NA	X	X	X	--
FC-SS-104	FC-SS-104	X	X	X	X
FC-SS-105	FC-SS-105	X	X	X	X
FC-SS-106	NA	X	X	X	--
FC-SS-107	NA	X	X	X	--
FC-SS-108	NA	X	X	X	--
FC-SS-109	FC-SS-109	X	X	X	X
FC-SS-116	NA	X	X	X	--
FC-SS-121	FC-SS-121	X	X	X	X
FC-SS-128	FC-SS-128	X	X	X	X
FC-SS-129	NA	X	X	X	--
Soil Boring Installation at the Concrete Pad and Well 4/CG					
FC-SB-101	NA	X	X	X	--
FC-SB-102	FC-SB-102-3545	X	X	X	X
	FC-SB-102-0607	X	X	X	X
FC-SB-103	FC-SB-103-3545	X	X	X	X
FC-SB-104	FC-SB-104-0102	X	X	X	X
	FC-SB-104-0607	X	X	X	X
FC-SB-105	NA	X	X	X	--
FC-SB-106	FC-SB-106-0203	X	X	X	X
	FC-SB-106-0607	X	X	X	X
FC-SB-107	NA	X	X	X	--
FC-SB-108	FC-SB-108-2535	X	X	X	X
	FC-SB-108-2535	X	X	X	X
FC-SB-109	NA	X	X	X	--
FC-SB-113	FC-SB-113-3545	X	X	X	X
FC-SB-114	FC-SB-114-0102	X	X	X	X
FC-SB-115	FC-SB-115-2535	X	X	X	X
FC-SB-116	NA	X	X	X	--
FC-SB-117	FC-SB-117-0203	X	X	X	X
FC-SB-118	NA	X	X	X	--
FC-SB-119	FC-SB-119-3545	X	X	X	X
FC-SB-120	NA	X	X	X	--
FC-SB-127	NA	X	X	X	--

TABLE A-2-1

SAMPLE IDENTIFICATION AND ANALYSIS SUMMARY
SITE 6A - FUEL CALIBRATION AREA
NWIRP CALVERTON, NEW YORK

Boring Number	Sample Identification	Visual	PID	PCB Test Kit (1)	Analytical Laboratory
QA/QC Samples					
Duplicate	DUP-012406-01 (2)	X	X	--	X
Duplicate	DUP-012506-02 (2)	X	X	--	X
Field Blank	FB-012506	--	--	--	X

Notes:
NA Not applicable.
PID Photo ionization detector.
-- Analysis not performed.

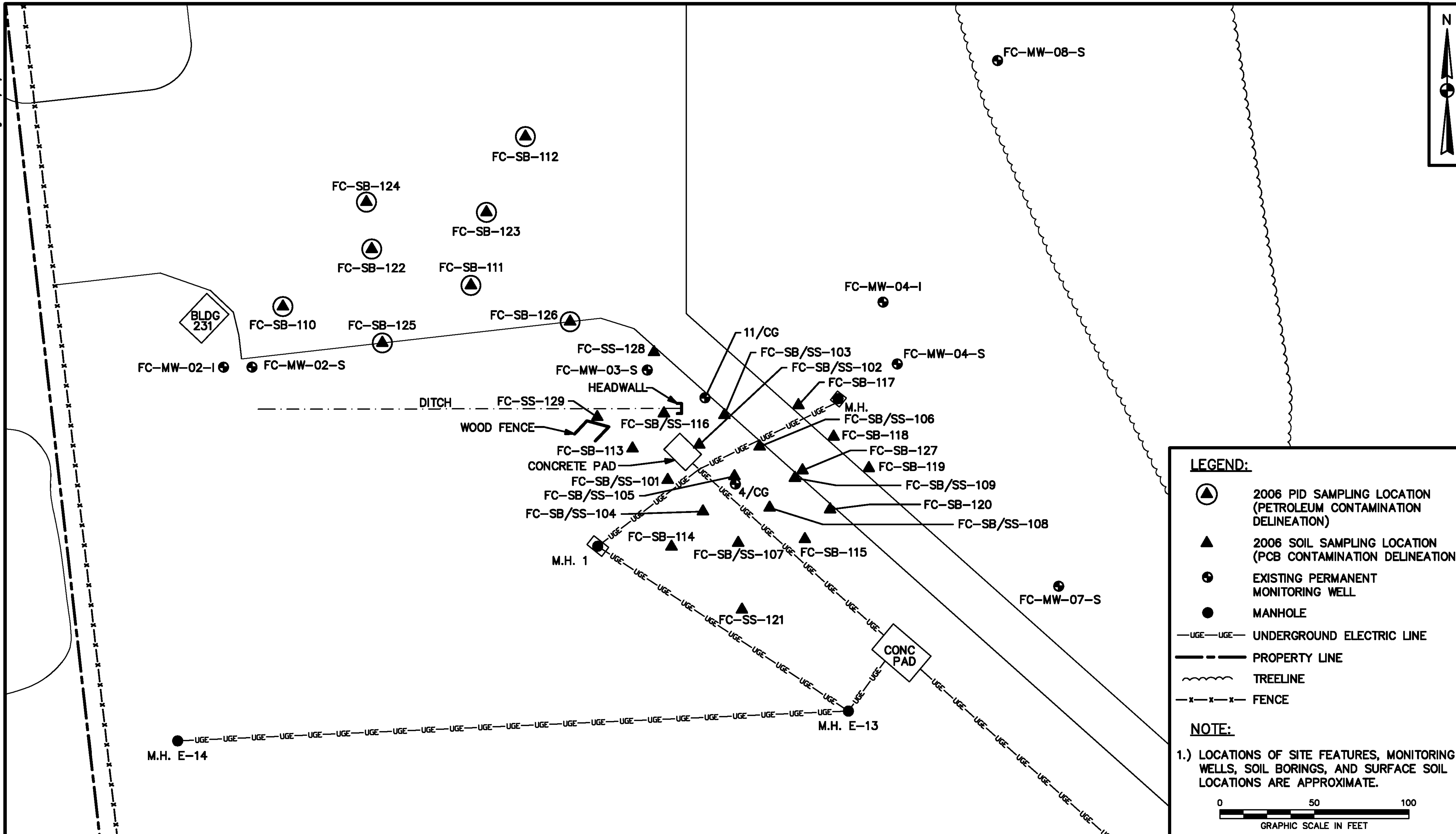
1. A positive PCB test kit result indicates that the PCB concentration of the surface soil sample is greater than 1,000 µg/kg or subsurface soil sample was greater than 10,000 µg/kg.

2. Duplicate samples were labeled using DUP, the day on which the duplicate was collected (e.g., 012406 represents January 24, 2006), and a number to represent the sequential number of duplicate collected (e.g., 01 indicates the first duplicate sample collected that day). Duplicate pairs are as follows:

DUP-012406-01	FC-SB-114-0102
DUP-012506-02	FC-SS-128

3. Field blanks were labeled using FB and the date to indicate the day on which the blank was collected (e.g., 012506 represents January 25, 2006).

ACAD:1610CM23.dwg 05/19/06 DT PIT



DRAWN BY MF / DATE 3/9/06	Tetra Tech NUS, Inc.	JANUARY 2006 SOIL SAMPLING AND PID SCREENING LOCATIONS SITE 6A - FUEL CALIBRATION AREA NWIRP CALVERTON CALVERTON, NEW YORK	CONTRACT NO. 1610	
CHECKED BY / DATE			OWNER NO. 004	
REVISED BY / DATE			APPROVED BY / DATE	
SCALE AS NOTED			DRAWING NO. FIGURE A-2-1	REV. 0

FORM CADD NO. TTNUS-BH.DWG - REV 1 - 9/10/98

3.0 ANALYTICAL RESULTS

Soil screening and soil analytical results from the 2006 investigation are presented in this section. Table A-3-1 provides visual classification information and PID measurements for the soil borings installed. A summary of PCB test kit and analytical laboratory results is presented in Table A-3-2. Analytical data as received from the laboratory are presented in Attachment C. Data validation letters are provided in Attachment D.

For the purpose of identifying the limits of petroleum contamination in soil at Site 6A, PID readings in excess of 50 parts per million (ppm) were interpreted to indicate the presence of petroleum contamination. This screening level was developed based on the visual characterization of the soil cuttings recorded on the soil boring log sheets. The 50 ppm screening criterion was consistent with the visual observation of stained soils and petroleum odors.

For the purposes of identifying the presence/limits of PCB contamination in soil at Site 6A, chemical concentrations were compared to values included in the NYSDEC Technical and Administrative Guidance Memorandum (TAGM) No. 4046, Determination of Soil Cleanup Objectives and Cleanup Levels. The TAGMs are non-enforceable guidance values intended to be protective of human health and the environment for a direct contact exposure scenario. The TAGM No. 4046 values were derived based on available chemical-specific toxicity data for carcinogenic and non-carcinogenic health effects. The TAGM No. 4046 criterion for PCB contamination is 1 milligram/kilograms (mg/kg) for surface soil and 10 mg/kg for subsurface soil.

3.1 PID SOIL SCREENING RESULTS

As indicated in Section 2 of this report, eight soil borings (FC-SB-110 through FC-SB-112 and FC-SB-122 through FC-SB-126) were installed in the area northwest of monitoring well 4/CG, and 17 soil borings (FC-SB-101 through FC-SB-109 and FC-SB-113 through FC-SB-120) were installed in the vicinity of monitoring well 4/CG. The eight soil boring located northwest of monitoring well 4/CG were installed to determine the northern extent of Site 6A petroleum-contaminated soil. The 17 soil borings installed in the vicinity of monitoring well 4/CG were installed to determine the extent of Site 6A PCB-contaminated soil. However, the soil cuttings from these 17 borings were also screened with a PID and were used to further define the southeastern limits of the Site 6A petroleum-contaminated soil.

3.1.1 PID Screening Results (Area Northwest of Monitoring Well 4/CG)

Four of the eight borings (FC-SB-110, FC-SB-111, FC-SB-125, and FC-SB-126) located northwest of monitoring well 4/CG exhibited high PID measurements, and the presence of a petroleum odor was recorded on the boring logs for these locations. The remaining borings located northwest of monitoring well 4/CG (FC-SB-112, FC-SB-122, FC-SB-123, and FC-SB-124) exhibited PID readings less than 50 ppm and no petroleum odor was recorded. Table A-3-1 summarizes the field observations and PID readings for the soil cuttings from these eight soil borings. Boring logs are presented in Attachment A.

3.1.2 PID Screening Results (Area in the Vicinity of Monitoring Well 4/CG)

Seven of the 17 borings (FC-SB-101, FC-SB-102, FC-SB-103, FC-SB-104, FC-SB-105, FC-SB-113, and FC-SB-116) located in the vicinity of monitoring well 4/CG exhibited high PID measurements, and the presence of a petroleum odor was recorded on the boring logs for these locations. The remaining borings located in the vicinity of monitoring well 4/CG (FC-SB-106 through FC-SB-109, FC-SB-114, FC-SB-115 and FCSB-117 through FC-SB-120) exhibited PID readings less than 50 ppm. In addition, no petroleum odor was reported for these locations, with the exception of FC-SB-109 and FC-SB-115, at which slight petroleum odors were reported. Table A-3-1 summarizes the field observations and PID readings for the soil cuttings from these 17 soil borings. Boring logs are presented in Attachment A.

3.1.3 PID Screening Results Summary

PID screening was performed on soil cuttings from 26 soil boring locations. The screening results indicated that 11 of the 26 Site 6A soil boring locations contain petroleum-contaminated soil (PID readings exceeded 50 ppm and petroleum odor was reported). These boring locations and the defined limits of the Site 6A petroleum-contaminated soil are presented on Figure A-3-1.

3.2 SOIL SAMPLING RESULTS

As indicated in Section 2, soil samples were collected from 21 soil boring locations to verify the presence of PCB soil contamination in the vicinity of monitoring well 4/CG and to define the horizontal and vertical extent of that contamination, if present. Initially, nine soil borings were advanced (FC-SB-101 through FC-SB-109), and soil samples were collected from multiple depth intervals within each boring location. The analytical results of this sampling effort resulted in the advancement of the remaining 12 soil borings (FC-SB-113 through FC-SB-121 and FC-SB-127 through FC-SB-129). With the exception of soil boring FC-SB-116, soil samples collected from these borings were collected from a single depth interval. Soil samples collected from soil boring FC-SB-116 were collected at two depth intervals. The sampling interval in these 12 soil borings was based on the analytical results of the soil samples obtained from the nine initial soil boring locations. In total, 35 soil samples were collected to verify and delineate the extent of PCB-contaminated soil in the vicinity of monitoring well 4/CG. All of the soil samples collected were analyzed for PCBs using a field test kit. Twenty of the 35 soil samples collected were sent to a fixed-base laboratory to verify the results of the analyses performed with the test kits. The following paragraphs describe the results of both the test kit and fixed-base laboratory analytical results.

3.2.1 PCB Test Kit Process and Results

Analysis Process – The Ensys PCB Soil Test Kit (including extraction kit) was used in the field to determine the presence of PCB-contaminated soil in the vicinity of monitoring well 4/CG. The process used to generate the test kit results included extracting a portion of the collected soil sample (sample extraction includes placing 10 grams of the collected soil sample into a vial with methanol) and subjecting the extraction to a sample preparation process. The preparation process included placing the soil extraction into the methanol vial, agitating the vial and allowing the mixture to stand, allowing PCBs to enter the methanol solution. The methanol is extracted from the vial and passed through a filter to remove any sediment/particulates and is then diluted to the appropriate detection criterion using the standard dilutions provided with the kit. The diluted extraction is then added to a buffer solution and placed into sampling tubes containing antibodies that react with the PCBs if present in the prepared solution. Then the PCB-enzyme conjugate is added to the solution and solution is incubated for 5 minutes, allowing the PCBs and PCB-enzyme conjugate to compete for antibody binding sites. After incubation, a color indicator is added to the sample tube. The change in solution color is then used to determine whether PCBs are in the sample in excess of the desired criterion. If the solution color becomes lighter than the standard, the test kit is indicating the presence of PCBs in excess of the desired criterion, and the result is reported as greater than the criterion. Conversely, if the solution color becomes darker than the standard, the test kit is indicating no PCBs or PCBs at concentrations less than the criterion, and the result is reported as less than the criterion. The detailed test kit analysis methodology is provided in Attachment E.

Test Kit Results – Test kit results from the initial 22 samples (collected from the initial nine soil boring locations) indicated the presence of PCBs in excess of the screening criteria (1 mg/kg for surface soils and 10 mg/kg for subsurface soils) in nine of the soil samples. Four of the nine exceedances occurred in surface soil samples (FC-SS-102-0005, FC-SS-104-0005, FC-SS-105-0005, and FC-SS-107-0005), which were collected at 0.0 to 0.5 foot bgs. The remaining exceedances were in subsurface soil samples (FC-SB-102-3545, FC-SB-104-0102, FC-SB-106-0203, FC-SB-108-2535, and FC-SB-109-3545) at varying sampling intervals (interval indicated by the last four digits of the sample number). These results verified that PCB-contaminated soil exists in the vicinity of monitoring well 4/CG; therefore, 12 additional samples at varying depths were collected from 11 additional boring locations to determine the horizontal and vertical extent of the PCB-contaminated soil. The test kits indicated that only 1 of the additional 12 samples (FC-SS-116-0005) contained PCB contamination in excess of the surface soil screening criterion, and none of the soil samples contained PCB concentrations in excess of the subsurface soil criterion. The results of the test kit analyses are summarized on Table A-3-2. The field forms containing the test kit results are provided in Attachment F).

3.2.2 PCB Analytical Laboratory Results

To verify the Ensys PCB Soil Test Kit results, 20 samples were sent to Severn Trent Laboratory Inc. in Pittsburgh, Pennsylvania for PCB analysis. The basis for selecting the samples to be sent to the fixed-base laboratory was the results of the field test kits and the sample locations. The results of the laboratory analysis are described in the following paragraphs. The analytical data are presented in Attachment C.

Surface Soil – Thirteen surface soil samples were collected at the vicinity of the concrete pad and well 4/CG. These 13 samples were analyzed using PCB field test kits. Six of these samples (FC-SS-102-0005, FC-SS-104-0005, FC-SS-105-0005, FC-SS-109-0005, FC-SS-121-0005, and FC-SS-128-0005) were also sent to the fixed-base laboratory for verification. Three of the surface soil samples sent to the analytical laboratory were believed to contain PCBs greater than 1 mg/kg based on field test kit results (FC-SS-102, FC-SS-104, and FC-SS-105), and the three other samples sent to the analytical laboratory were believed to contain PCBs less than 1 mg/kg based on field test kit results (FC-SS-109, FC-SS-121, and FC-SS-128). Analytical laboratory results confirmed the field test kit results for surface soils at the concrete pad and well 4/CG. The highest concentration of PCBs detected was 330 mg/kg in FC-SS-102.

Subsurface Soil - Twenty-two subsurface soil samples were collected in the vicinity of the concrete pad and well 4/CG. These 22 samples were analyzed using PCB field test kits. Fourteen of these samples (FC-SB-102-3545, FC-SB-102-0607, FC-SB-103-3545, FC-SB-104-0102, FC-SB-104-0607, FC-SB-106-0203, FC-SB-106-0607, FC-SB-108-2535, FC-SB-108-0607, FC-SB-113-3545, FC-SB-114-0102, FC-SB-115-2535, FC-SB-117-0203, and FC-SB-119-3545) were also sent to the fixed-base laboratory for verification. Four of the subsurface soil samples sent to the analytical laboratory were believed to contain PCBs greater than 10 mg/kg based on field test kit results (FC-SB-102-3545, FC-SB-104-0102, FC-SB-106-0203, and FC-SB-108-2535). Analytical laboratory results for these four samples did not confirm PCB concentrations in excess of 10 mg/kg. The highest concentration detected was 5.4 mg/kg in FC-SB-102-3545. The remaining 10 samples sent to the analytical laboratory were believed to contain PCBs less than 10 mg/kg based on field test kit results (FC-SB-102-0607, FC-SB-103-3545, FC-SB-104-0607, FC-SB-106-0607, FC-SB-108-0607, FC-SB-113-3545, FC-SB-114-0102, FC-SB-115-2535, FC-SB-117-0203, and FC-SB-119-3545). Analytical laboratory results confirmed the field test kit results for nine of the samples. One sample, FC-SB-104-0607, was believed to contain PCBs less than 10 mg/kg based on field test kit results but actually contained PCBs at a concentration of 17 mg/kg based on analytical laboratory results. This concentration was the highest concentration of PCBs in subsurface soil.

3.2.3 Analytical Laboratory Correlation Resolution

As indicated in Section 3.2.2, 20 samples were sent to a fixed-base laboratory to verify the results of the 35 soil samples analyzed with the field test kits. The results of the surface soil samples had 100 percent correlation. However, the results of the subsurface soil samples had 64 percent correlation. The reason for the low correlation percentage with the subsurface samples was a result of 5 of the 14 laboratory samples having different results from the test kit results. The five inconsistencies are summarized below.

Sample Number	Field Test Kit Result	Analytical Laboratory Result
FC-SB-102-3545	>10 mg/kg	5.4 mg/kg
FC-SB-104-0102	>10 mg/kg	0.094 mg/kg
FC-SB-104-0607	<10 mg/kg	17 mg/kg
FC-SB-106-0203	>10 mg/kg	ND
FC-SB-108-2535	>10 mg/kg	ND

ND - Not detected.

Due to the order of magnitude difference between some of these results (e.g., greater than 10 mg/kg and non-detect), an evaluation of these inconsistencies was performed. A review of the test kit field forms (provided in Attachment F) indicates that four of the five inconsistencies were in the same batch (FC-SB-102-3545, FC-SB-104-1020, FC-SB-106-0203, and FC-SB-108-2535) analyzed on January 24, 2006, and the other inconsistency (FC-SB-104-0607) was analyzed on January 25, 2006. Based on the evaluation of the field test kit process and a review of the test kit data that did correlate with the analytical results, it was determined that the interpretations of the field test kit results were accurate. Therefore, the data were compared to the results from neighboring sampling locations (results from the same soil boring locations and results from adjacent soil boring locations) and the following conclusions were drawn.

- The field test kit result (greater than 10 mg/kg) for FC-SB-3545 was used because of the proximity of the soil boring to the concrete pad and the results of the surface soil sampling interval within the same soil boring (330 mg/kg).

- The analytical laboratory result (0.094 mg/kg) for FC-SB-104-0102 was used because of the proximity of the soil borings to the concrete pad and because the deeper subsurface detection (17 mg/kg) at this location was located within the groundwater smear zone.

- The analytical laboratory result (17 mg/kg) for FC-SB-104-0607 was used because of the proximity of the soil boring to the concrete pad and because the sample interval is located within the groundwater smear zone.

- The analytical laboratory result (non-detect) for FC-SB-106-0203 was used because of the proximity of the soil borings to the concrete pad and because the surface soil sample result in the same soil boring was less than 1 mg/kg.

- The analytical laboratory result (non-detect) for FC-SB-108-2535 was used because of the proximity of the soil boring to the concrete pad and because the surface soil sample result in the same soil boring was less than 1 mg/kg.

Using the selected results from the uncorrelated data and the results from the correlated data, the extent of PCB contamination in surface soil (0.0 to 0.5 foot bgs) is well defined. Using this same data, the extent of PCB contamination in the subsurface soil is well defined with the exception of the southwestern extent where no data are available within the groundwater smear zone (6.0 to 7.0 feet bgs) at boring location FC-SB/SS-101. The field test kit and analytical laboratory results are summarized in Table A-3-2, and the extent of PCB contamination is identified on Figure A-3-2.

TABLE A-3-1

SUMMARY OF VISUAL OBSERVATIONS AND PID MEASUREMENTS FOR THE AREA NORTH OF THE CONCRETE PAD AND WELL 4/CG
SITE 6A - FUEL CALIBRATION AREA
NWIRP CALVERTON, NEW YORK

Boring Number	Depth (ft bgs)	Field Observations	Max PID (ppm)	Depth of Max PID (ft bgs)
FC-SB-101	0 - 4.5	PID < 50 ppm, Tan Fine-Medium Grained Sand.	23.6	4.5
	4.5 - 8	PID > 50 ppm, Gray Fine-Medium Grained Sand.	258	7
FC-SB-102	0 - 4	PID < 50 ppm, Brown Sand and Silt.	25.2	4
	4 - 8	PID > 50 ppm, Gray Fine-Medium Grainrd Sand.	195	7.5
FC-SB-103	0 - 4	PID < 50 ppm, Gray-Green Fine Grained Sand and some Silt.	14.9	4
	4 - 8	PID > 50 ppm, Gray fine-medium Grained Sand.	220	8
FC-SB-104	0 - 5	PID < 50 ppm, Tan Fine-Medium Grained Sand.	44.3	5
	5 - 8	PID > 50 ppm, Gray Fine-Medium Grained Sand.	220	7..5
FC-SB-105	0 - 6	PID < 50 ppm, Gray Fine-Medium Grained Sand.	7.2	5.5
	6 - 8	PID > 50 ppm, Gray Fine-Medium Grained Sand.	134	7
FC-SB-106	0 - 8	PID < 5 ppm, Brown Sand with Trace Silt.	2.8	1
FC-SB-107	0 - 8	PID < 5 ppm, Brown sand some Silt Trace Clay.	2.1	4
FC-SB-108	0 - 8	PID < 1 ppm, Tan Sand with Trace Silt.	0.8	4
FC-SB-109	0 - 8	PID < 5 ppm, Brown Fine-Medium Grained Sand Trace Silt.	1.8	4
FC-SB-110	0 - 5.5	PID < 50 ppm, Brown/Green/Gray Sand with Silt.	41.8	5.5
	5.5 - 8	PID > 50 ppm, Gray Sand, Petroleum Odor.	194	6.5
FC-SB-111	0 - 8	PID > 50 ppm, Gray/Green/Brown/Black Sand, Petroleum Odor.	444	6
FC-SB-112	0 - 8	PID < 50 ppm, Gray/Brown Sand.	2	2
FC-SB-113	0 - 4	PID < 50 ppm, Green/Tan Sand with Trace Silt.	44.5	4
	4 - 8	PID > 50 ppm, Gray Fine-Medium Grained Sand.	354	7.5
FC-SB-114	0 - 8	PID = 0 ppm, Brown/Gray Sand with some Silt.	0	0 - 8
FC-SB-115	0 - 8	PID < 1 ppm, Brown Sand with Silt and Trace Clay.	0.6	1
FC-SB-116	0 - 4	PID < 50 ppm, Tan Fine-Medium Grained Sand with Trace Silt.	2.8	5
	4 - 8	PID > 50 ppm, Gray Fine-Medium Grained Sand.	294	6.5
FC-SB-117	0 - 8	PID = 0 ppm, Brown/Gray Fin-Medium Grained Sand.	0	0 - 8
FC-SB-118	0 - 8	PID = 0 ppm, Brown/Gray/Tan Fin-Medium Grained Sand.	0	0 - 8

TABLE A-3-2

SUMMARY OF PCB TEST KIT AND ANALYTICAL RESULTS AT THE
CONCRETE PAD AND WELL 4/CG AREA
SITE 6A - FUEL CALIBRATION AREA
NWIRP CALVERTON, NEW YORK

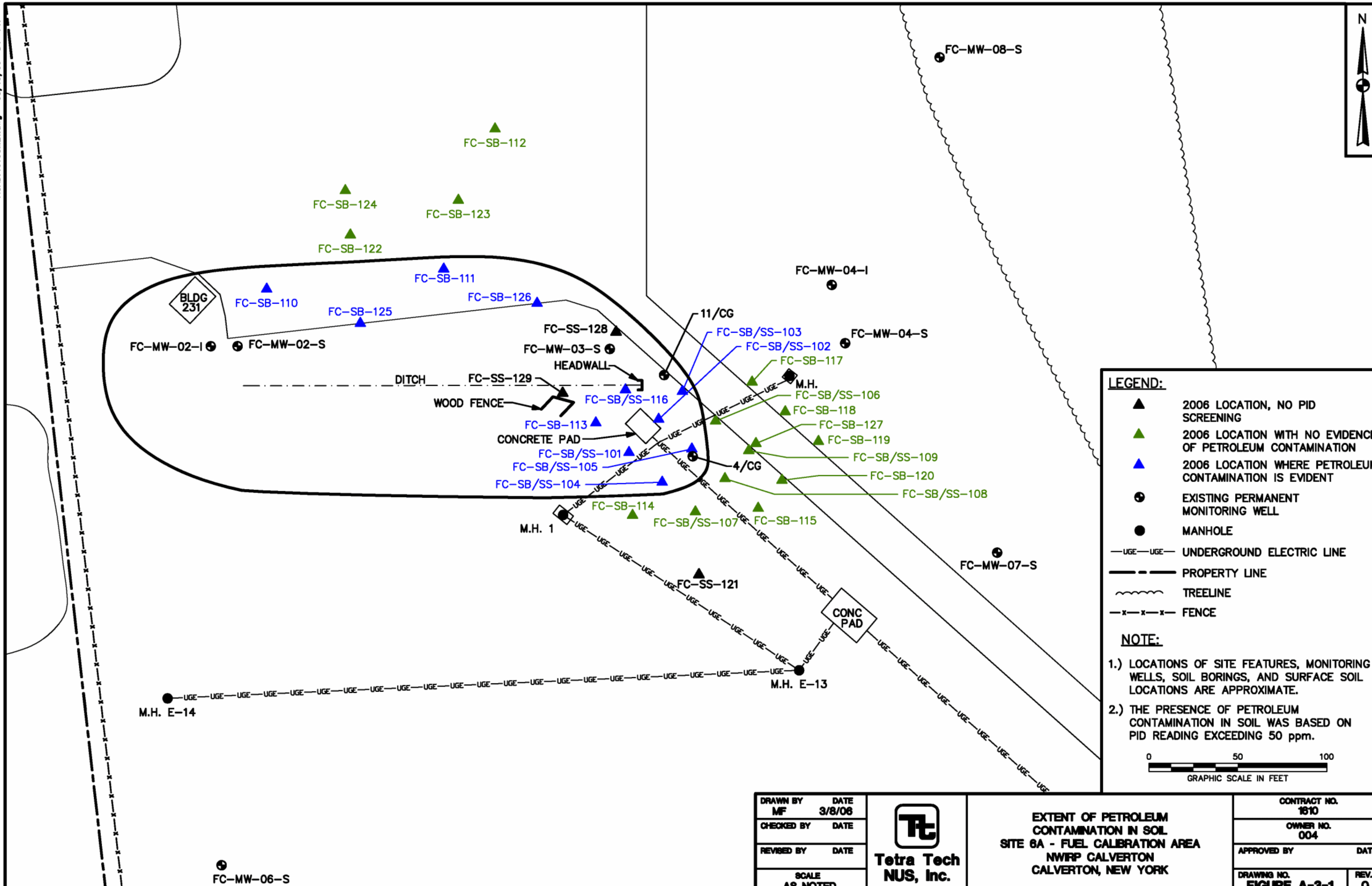
Boring Number	Depth (ft bgs)	Screening Criterion (mg/kg)	PCB Test Kit Result (mg/kg) (1)	Laboratory Total PCBs Results (mg/kg) (1)	Correlation (2)
Surface and Subsurface Soil Samples					
FC-SS-101	0 - 0.5	1	< 1	--	NA
	3.5 - 4.5	10	< 10	--	NA
FC-SS-102	0 - 0.5	1	> 1	330	Y
	3.5 - 4.5	10	> 10	5.4	N
	6 - 7	10	< 10	2.1	Y
FC-SS-103	0 - 0.5	1	< 1	--	NA
	3.5 - 4.5	10	< 10	0.41	Y
FC-SS-104	0 - 0.5	1	> 1	3.1	Y
	1 - 2	10	> 10	0.094	N (3)
	6 - 7	10	< 10	17	N
FC-SS-105	0 - 0.5	1	> 1	2.1	Y
	2.5 - 3.5	10	< 10	--	NA
FC-SS-106	0 - 0.5	1	< 1	--	NA
	2 - 3	10	> 10	ND	N (3)
	6 - 7	10	< 10	ND	Y
FC-SS-107	0 - 0.5	1	> 1	--	NA
	2 - 3	10	< 10	--	NA
FC-SS-108	0 - 0.5	1	< 1	--	NA
	2.5 - 3.5	10	> 10	ND	N (3)
	6 - 7	10	< 10	ND	Y
FC-SS-109	0 - 0.5	1	< 1	0.091	Y
	3.5 - 4.5	10	> 10	--	NA (4)
FC-SB-113	3.5 - 4.5	10	< 10	0.011	Y
FC-SB-114	1 - 2	10	< 10	ND	Y
FC-SB-115	2.5 - 3.5	10	< 10	ND	Y
FC-SS-116	0 - 0.5	1	> 1	--	NA
	2.5 - 3.5	10	< 10	--	NA
FC-SB-117	2 - 3	10	< 10	ND	Y
FC-SB-118	3.5 - 4.5	10	< 10	--	NA
FC-SB-119	3.5 - 4.5	10	< 10	ND	Y
FC-SB-120	2 - 3	10	< 10	--	NA
FC-SS-121	0 - 0.5	1	< 1	0.47	Y
FC-SB-127	3.5 - 4.5	10	< 10	--	NA
FC-SS-128	0 - 0.5	1	< 1	ND	Y
FC-SS-129	0 - 0.5	1	< 1	--	NA
QA/QC Samples					
DUP-012406-01	NA	--	--	ND	NA
DUP-012506-02	NA	--	--	ND	NA
FB-012506	NA	--	--	ND	NA

-- Indicates that the sample was not sent for laboratory analysis
NA Correlation consideration is not applicable.

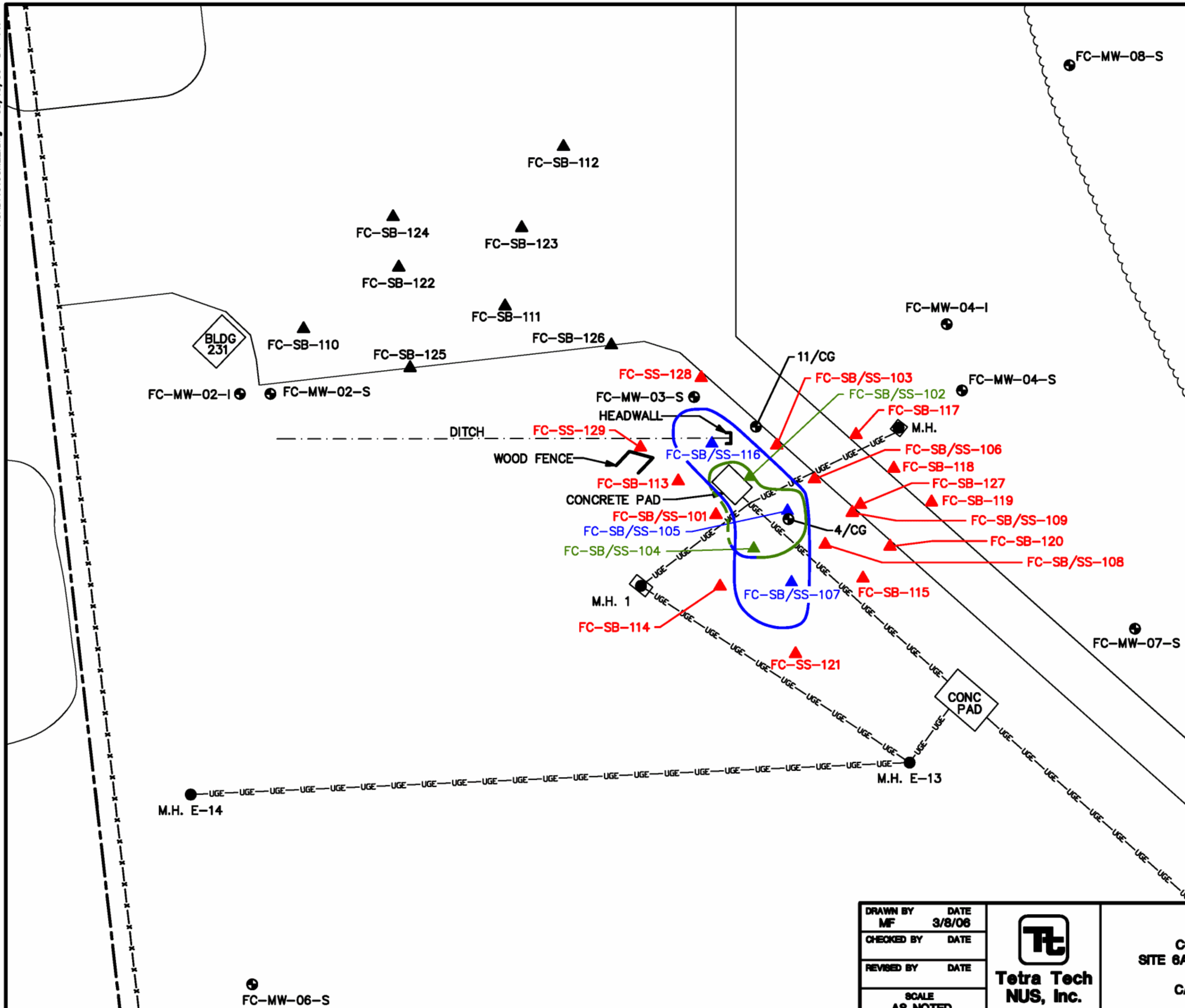
(1) Shaded results indicate an exceedance of the screening value.
(2) Correlation between field kit and laboratory result is indicated with "Y". No correlation between field kit and laboratory indicated with "N".
(3) Laboratory data used to define extent of PCB contamination due to non-correlation and issues with test kit standard.

(4) Test kit considered unreliable due to non-correlation in other samples evaluated in the same sample batch.

ACAD:1610CM21.dwg 05/19/06 DT PIT



FORM CADD NO. TTNUS-BH.DWG - REV 1 - 9/10/98



LEGEND:

- EXTENT OF PCB CONTAMINATION IN SUB-SURFACE SOIL (GROUNDWATER INTERFACE)
- EXTENT OF PCB CONTAMINATION IN SURFACE SOIL
- 2006 LOCATION, NO PCB SAMPLING
- 2006 LOCATION WHERE PCB CONCENTRATIONS EXCEED SCREENING CRITERIA (SURFACE SOIL ONLY)
- 2006 LOCATION WHERE PCB CONCENTRATIONS EXCEED SCREENING CRITERIA (SURFACE AND SUBSURFACE SOIL)
- 2006 LOCATION WHERE PCB CONCENTRATIONS ARE BELOW SCREENING CRITERIA (SURFACE AND SUBSURFACE SOIL)
- EXISTING PERMANENT MONITORING WELL
- MANHOLE
- —UGE—UGE— UNDERGROUND ELECTRIC LINE
- PROPERTY LINE
- TREELINE
- —x—x—x— FENCE

NOTE:

1.) LOCATIONS OF SITE FEATURES, MONITORING WELLS, SOIL BORINGS, AND SURFACE SOIL LOCATIONS ARE APPROXIMATE.

2.) THE PRESENCE OF PCB CONTAMINATION IN SOIL WAS BASED ON SAMPLE RESULTS EXCEEDING 1 ppm IN SURFACE SOIL AND 10 ppm IN SUBSURFACE SOIL.

0 50 100
GRAPHIC SCALE IN FEET

DRAWN BY MF	DATE 3/8/06	Tetra Tech NUS, Inc.	EXTENT OF PCB CONTAMINATION IN SOIL SITE 6A - FUEL CALIBRATION AREA NWIRP CALVERTON CALVERTON, NEW YORK	CONTRACT NO. 1610
CHECKED BY	DATE			OWNER NO. 004
REVISED BY	DATE			APPROVED BY / DATE
SCALE AS NOTED				DRAWING NO. FIGURE A-3-2 / REV. 0

4.0 CONCLUSIONS

Previous investigations at Site 6A identified petroleum-contaminated soil northwest and in the vicinity of the concrete pad (former transformer pad) and monitoring well 4/CG. However, data gaps were noted in the delineation of petroleum-contaminated soil northwest of the concrete pad and monitoring well 4/CG. In addition, previous investigations identified the potential presence of PCB-contaminated soil in the vicinity of the former transformer concrete pad and well 4/CG. However, previous investigations did not include the investigation of the soil in this area. Therefore, the purpose of the January 2006 field investigation was to better define the extent of petroleum-contaminated soil and to verify the presence of PCB-contaminated soil and the extent (horizontal and vertical) of PCB-contaminated soil.

The following conclusions can be drawn from the January 2006 field investigation results:

Extent of Petroleum-Contaminated Soil at Site 6A - Sufficient data have been collected to accurately delineate the extent of petroleum-contaminated soil northwest of and in the vicinity of the concrete pad (formerly used as a transformer pad) and monitoring well 4/CG. In addition, sufficient data have been collected to accurately update the CMS alternative evaluations and cost estimates for the removal of petroleum-contaminated soils.

Presence of PCB-Contaminated Soil at Site 6A - Sufficient data have been collected to verify the presence of PCB-contaminated soil in the vicinity of the concrete pad and monitoring well 4/CG at concentrations that exceed 50 mg/kg.

Extent of PCB-Contaminated Soil at Site 6A - Sufficient data have been collected to accurately delineate the horizontal extent of PCB contamination in surface soils (PCB concentration in excess of 1 mg/kg). In addition, sufficient data have been collected to accurately delineate the extent of PCB contamination in subsurface soil (PCB concentrations in excess of 10 mg/kg) above the groundwater smear zone (1 to 6 feet bgs). However, the horizontal extent of PCB contamination in the subsurface soil within the groundwater smear zone (6 to 7 feet bgs) requires further investigation prior to implementation of selected remedial alternatives.

The delineated extent of petroleum-contaminated soil is presented in Figure A-3-1. The delineated extent of PCB-contaminated soil is presented in Figure A-3-2.

ATTACHMENT A

SOIL BORING LOGS

Tetra Tech NUS, Inc.

BORING LOG

Page ___ of ___

PROJECT NAME: NWIRP Calverton
PROJECT NUMBER: 1610/CTO 004
DRILLING COMPANY: LVS, Inc.
DRILLING RIG: Geoprobe®

BORING No.: FC-SB-101
DATE: 1-24-06
GEOLOGIST: Neb Dedic
DRILLER: Chris O'Shea

Sample No. and Type or RQD	Depth (Ft.) or Run No.	Blows / 6" or RQD (%)	Sample Recovery / Sample Length	Lithology Change (Depth/Ft.) or Screened Interval	MATERIAL DESCRIPTION: Soil Density/ Consistency or Rock Hardness	Color	Material Classification	USCS *	Remarks	PID/FID Reading (ppm): Sample	Sampler BZ	Borehole**	Driller BZ**
						DRK BRN	sandy LOAM		moist			0.5	
	1					BRN	f. sand some silt tr. clay					1.2	
			44/48									2.1	
	2											2.6	
												2.9	
	3											3.2	
												3.0	
	4								odor or product			3.1	
S-1						tan	f-m sand, tr silt					23.6	
	5								~GW wet			203	
			45/48			gB	f-m sand					192	
	6											137	
												141	
	7											258	
												352	
	8											325	
				EOB									
	9												
	10												
	11												
	12												

* When rock coring, enter rock brokeness.

** Include monitor reading in 6 foot intervals @ borehole. Increase reading frequency if elevated reponse read.

Remarks: ______

Drilling Area Background (ppm): 0.0

Converted to Well: Yes ____ No ✓ Well I.D. #: ______

Tetra Tech NUS, Inc.

BORING LOG

Page ___ of ___

PROJECT NAME:	NWIRP Calverton	BORING No.:	FC-SB-102
PROJECT NUMBER:	1610/CTO 004	DATE:	1-24-06
DRILLING COMPANY:	LVS, Inc.	GEOLOGIST:	Neb Dedic
DRILLING RIG:	Geoprobe®	DRILLER:	Chris O'Shea

Sample No. and Type or RQD	Depth (Ft.) or Run No.	Blows / 6" or RQD (%)	Sample Recovery / Sample Length	Lithology Change (Depth/Ft.) or Screened Interval	MATERIAL DESCRIPTION: Soil Density/ Consistency or Rock Hardness	Color	Material Classification	USCS *	Remarks	PID/FID Reading (ppm): Sample	Sampler BZ	Borehole**	Driller BZ**
						DRK brn	sandy loam		moist				
	1					brn	sand w silt						
												0.1	
	2											0.6	
				brn								0.7	
	3		36/48									0.7	
							sand some silt		slight odor on product			1.4	
	4			brn								25.2	
S-1				tan		tan	f-m sand		~GW wet			80.2	
	5					gry			odor			121	
												128	
	6			gry								139	
												137	
S-2	7											192	
												195	
	8												
				EOB									
	9												
	10												
	11												
	12												

* When rock coring, enter rock brokeness.

** Include monitor reading in 6 foot intervals @ borehole. Increase reading frequency if elevated reponse read.

Remarks: ______________________

Drilling Area Background (ppm): 0.0

Converted to Well: Yes ______ No ✓ Well I.D. #: ______________

Tetra Tech NUS, Inc.

BORING LOG

Page ___ of ___

PROJECT NAME:	NWIRP Calverton	BORING No.:	FC-SB-103
PROJECT NUMBER:	1610/CTO 004	DATE:	1-24-06
DRILLING COMPANY:	LVS, Inc.	GEOLOGIST:	Neb Dedic
DRILLING RIG:	Geoprobe®	DRILLER:	Chris O'Shea

Sample No. and Type or RQD	Depth (Ft.) or Run No.	Blows / 6" or RQD (%)	Sample Recovery / Sample Length	Lithology Change (Depth/Ft.) or Screened Interval	MATERIAL DESCRIPTION: Soil Density/ Consistency or Rock Hardness	Color	Material Classification	USCS*	Remarks	PID/FID Reading (ppm): Sample	Sampler BZ	Borehole**	Driller BZ**
						DRK BRN	Sandy Loam		moist			0.8	
	1					BRN	f. sand some silt tr. clay					1.7	
			40/48									1.8	
	2											1.7	
												1.8	
	3											21	
						grey grn	f. sand some silt tr. clay, tr M-C sand					5.1	
	4								odor or Product			14.4	
S-1									~GW wet			74.5	
	5					gray	f-M sand, tr. silt					108	
												152	
	6		39/48									93	
												89	
	7											132	
												155	
	8											220	
				EOB									
	9												
	10												
	11												
	12												

* When rock coring, enter rock brokeness.

** Include monitor reading in 6 foot intervals @ borehole. Increase reading frequency if elevated reponse read.

Drilling Area Background (ppm): 0.0

Remarks: ____________________

Converted to Well: Yes ______ No ✓ Well I.D. #: ______

Tetra Tech NUS, Inc.

BORING LOG

Page ___ of ___

PROJECT NAME:	NWIRP Calverton	BORING No.:	FC-SB-104
PROJECT NUMBER:	1610/CTO 004	DATE:	1-24-06
DRILLING COMPANY:	LVS, Inc.	GEOLOGIST:	Neb Dedic
DRILLING RIG:	Geoprobe®	DRILLER:	Chris O'Shea

Sample No. and Type or RQD	Depth (Ft.) or Run No.	Blows / 6" or RQD (%)	Sample Recovery / Sample Length	Lithology Change (Depth/Ft.) or Screened Interval	MATERIAL DESCRIPTION: Soil Density/ Consistency or Rock Hardness	Color	Material Classification	U S C S *	Remarks	PID/FID Reading (ppm): Sample	Sampler BZ	Borehole**	Driller BZ**
						DRK brn	sandy Loam		moist				
	1					brn	f-m sand w silt					1.8	
							tr. clay					1.8	
S-1	2			brn								2.1	
			45/48									2.0	
	3											2.0	
							f-m sand, some silt		slight odor			2.6	
	4			brn								2.5	
				tan		tan	f-m sand		~ GW wet			44.3	
	5			gry		gry			odor			28	
												132	
	6		40/48									112	
												134	
S-2	7											215	
												220	
	8												
				EOB									
	9												
	10												
	11												
	12												

* When rock coring, enter rock brokeness.

** Include monitor reading in 6 foot intervals @ borehole. Increase reading frequency if elevated reponse read.

Remarks: ____________

Drilling Area Background (ppm): 0.0

Converted to Well: Yes ______ No ✓ Well I.D. #: ______

Tetra Tech NUS, Inc.

BORING LOG

Page ___ of ___

PROJECT NAME:	NWIRP Calverton	BORING No.:	FC-SB-105
PROJECT NUMBER:	1610/CTO 004	DATE:	1-24-06
DRILLING COMPANY:	LVS, Inc.	GEOLOGIST:	Neb Dedic
DRILLING RIG:	Geoprobe®	DRILLER:	Chris O'Shea

Sample No. and Type or RQD	Depth (Ft.) or Run No.	Blows / 6" or RQD (%)	Sample Recovery / Sample Length	Lithology Change (Depth/Ft.) or Screened Interval	MATERIAL DESCRIPTION: Soil Density/ Consistency or Rock Hardness	MATERIAL DESCRIPTION: Color	MATERIAL DESCRIPTION: Material Classification	U S C S *	Remarks	PID/FID Reading (ppm): Sample	PID/FID Reading (ppm): Sampler BZ	PID/FID Reading (ppm): Borehole**	PID/FID Reading (ppm): Driller BZ**
						DRK BRN	Sandy LOAM		moist			0.5	
	1					BRN	silty sand some cly					0.5	
												0.5	
	2		42/48									0.8	
												1.3	
	3						sand some silt					1.1	
S-1												0.8	
	4											0.5	
						gry	f-m sand						
	5								~GW wet				
									odor or product			7.2	
	6		36/48									2.5	
												131	
	7											134	
												115	
	8											112	
	9												
	10												
	11												
	12												

* When rock coring, enter rock brokeness.

** Include monitor reading in 6 foot intervals @ borehole. Increase reading frequency if elevated reponse read.

Remarks: ______

Drilling Area Background (ppm): 0.0

Converted to Well: Yes ______ No ______ Well I.D. #: ______

Tetra Tech NUS, Inc.

BORING LOG

PROJECT NAME:	NWIRP Calverton	BORING No.:	FC-SB-106
PROJECT NUMBER:	1610/CTO 004	DATE:	1-24-06 / 1-25-06
DRILLING COMPANY:	LVS, Inc.	GEOLOGIST:	Neb Dedic
DRILLING RIG:	Geoprobe®	DRILLER:	Chris O'Shea

Sample No. and Type or RQD	Depth (Ft.) or Run No.	Blows / 6" or RQD (%)	Sample Recovery / Sample Length	Lithology Change (Depth/Ft.) or Screened Interval	MATERIAL DESCRIPTION: Soil Density/ Consistency or Rock Hardness	Color	Material Classification	U S C S *	Remarks	PID/FID Reading (ppm): Sample	Sampler BZ	Borehole**	Driller BZ**
						Dk brn	Sandy Loam		Moist				
	1					brn	Sand w silt, tr					2.8	
							Clay + f. gravel					2.7	
	2			brn								2.5	
			40/48									2.4	
S-1	3			grn		grn	Sand some silt					2.3	
						brn	Sand w silt, tr clay					2.3	
	4			brn								2.2	
				tan		tan	f-m sand tr silt						
	5			gry		gry			~GW wet			1.8	
												1.8	
	6											1.7	
												1.8	
S-2	7		42/48									1.8	
												1.8	
	8												
				EOB									
	9												
	10												
	11												
	12												

* When rock coring, enter rock brokeness.

** Include monitor reading in 6 foot intervals @ borehole. Increase reading frequency if elevated reponse read.

Drilling Area Background (ppm): 0.0

Remarks: ______

Converted to Well: Yes ____ No ✓ Well I.D. #: ______

Tetra Tech NUS, Inc.

BORING LOG

PROJECT NAME: NWIRP Calverton
PROJECT NUMBER: 1610/CTO 004
DRILLING COMPANY: LVS, Inc.
DRILLING RIG: Geoprobe®

BORING No.: FC-SB-107
DATE: 1-24-06
GEOLOGIST: Neb Dedic
DRILLER: Chris O'Shea

Sample No. and Type or RQD	Depth (Ft.) or Run No.	Blows / 6" or RQD (%)	Sample Recovery / Sample Length	Lithology Change (Depth/Ft.) or Screened Interval	MATERIAL DESCRIPTION: Soil Density/ Consistency or Rock Hardness	MATERIAL DESCRIPTION: Color	MATERIAL DESCRIPTION: Material Classification	U S C S *	Remarks	PID/FID Reading (ppm): Sample	PID/FID Reading (ppm): Sampler BZ	PID/FID Reading (ppm): Borehole**	PID/FID Reading (ppm): Driller BZ**
						DRK BRN	sandy LOAM		moist				
	1					BRN	silty sand some clay						
												1.4	
	2		42/48									1.9	
												2	
S-1	3											1.5	
							sand, some silt tr. clay					1.6	
	4											2.1	
						tan	f-m sand, tr silt					1.2	
	5					gry	f-m sand		~GW wet			1.1	
												1.5	
	6		40/48									1.2	
												1.2	
	7											1.1	
												1.1	
	8												
				EOB									
	9												
	10												
	11												
	12												

* When rock coring, enter rock brokeness.

** Include monitor reading in 6 foot intervals @ borehole. Increase reading frequency if elevated reponse read.

Remarks: ______

Drilling Area Background (ppm): 0.0

Converted to Well: Yes ____ No ✓ Well I.D. #: ______

Tetra Tech NUS, Inc.

BORING LOG

Page ___ of ___

PROJECT NAME: NWIRP Calverton
PROJECT NUMBER: 1610/CTO 004
DRILLING COMPANY: LVS, Inc.
DRILLING RIG: Geoprobe®

BORING No.: FC-SB-108
DATE: 1-24-06
GEOLOGIST: Neb Dedic
DRILLER: Chris O'Shea

Sample No. and Type or RQD	Depth (Ft.) or Run No.	Blows / 6" or RQD (%)	Sample Recovery / Sample Length	Lithology Change (Depth/Ft.) or Screened Interval	MATERIAL DESCRIPTION: Soil Density/ Consistency or Rock Hardness	Color	Material Classification	USCS *	Remarks	PID/FID Reading (ppm): Sample	Sampler BZ	Borehole**	Driller BZ**
						DRK brn	sandy LOAM		moist			0.0	
	1					brn	sand w silt tr. clay					0.0	
				brn								0.0	
	2		44/48									0.3	
						tan	sand some silt					0.3	
	3			tan								0.3	
S-1							sand tr. silt					0.3	
	4											0.8	
												0.5	
	5					gry			~6' wet			0.4	
			45/48	gry								0.5	
	6											0.4	
												0.6	
S-2	7											0.6	
												0.7	
	8											0.7	
				EOB									
	9												
	10												
	11												
	12												

* When rock coring, enter rock brokeness.

** Include monitor reading in 6 foot intervals @ borehole. Increase reading frequency if elevated reponse read.

Remarks: ______

Drilling Area Background (ppm): 0.0

Converted to Well: Yes ____ No ✓ Well I.D. #: ______

Tetra Tech NUS, Inc.

BORING LOG

Page ___ of ___

PROJECT NAME:	NWIRP Calverton	BORING No.:	FC-SB-109
PROJECT NUMBER:	1610/CTO 004	DATE:	1-24-06
DRILLING COMPANY:	LVS, Inc.	GEOLOGIST:	Neb Dedic
DRILLING RIG:	Geoprobe®	DRILLER:	Chris O'Shea

Sample No. and Type or RQD	Depth (Ft.) or Run No.	Blows / 6" or RQD (%)	Sample Recovery / Sample Length	Lithology Change (Depth/Ft.) or Screened Interval	MATERIAL DESCRIPTION: Soil Density/ Consistency or Rock Hardness	Color	Material Classification	U S C S *	Remarks	PID/FID Reading (ppm): Sample	Sampler BZ	Borehole**	Driller BZ**
						DRK BRN	Sandy Loam		Moist			0.1	
	1					BRN	Sand some silt					0.5	
									tr. f. gravel			1.0	
	2		42/48									1.3	
												1.3	
	3											1.2	
							~1", DRK green-gry f-m sand tr. silt					1.6	
	4			Brn			f-m sand tr. silt					1.8	
S-1						tan						1.4	
	5			tan					~GW wet			1.5	
						gry	f-m sand		slight odor or product			1.2	
	6		42/48	gry								1.6	
												1.6	
	7											1.4	
												1.4	
	8												
				EOB									
	9												
	10												
	11												
	12												

* When rock coring, enter rock brokeness.

** Include monitor reading in 6 foot intervals @ borehole. Increase reading frequency if elevated reponse read.

Remarks: ______

Drilling Area Background (ppm): 0.0

Converted to Well: Yes ______ No ______ Well I.D. #: ______

Tetra Tech NUS, Inc.

BORING LOG

Page ___ of ___

PROJECT NAME:	NWIRP Calverton	BORING No.:	FC-SB-110
PROJECT NUMBER:	1610/CTO 004	DATE:	1-24-06
DRILLING COMPANY:	LVS, Inc.	GEOLOGIST:	Neb Dedic
DRILLING RIG:	Geoprobe®	DRILLER:	Chris O'Shea

Sample No. and Type or RQD	Depth (Ft.) or Run No.	Blows / 6" or RQD (%)	Sample Recovery / Sample Length	Lithology Change (Depth/Ft.) or Screened Interval	MATERIAL DESCRIPTION: Soil Density/ Consistency or Rock Hardness	Color	Material Classification	U S C S *	Remarks	PID/FID Reading (ppm): Sample	Sampler BZ	Borehole**	Driller BZ**
						gry	concrete						
	1												
				brn		brn	sand tr. silt		moist			10.8	
	2		30/36									–	
												6.4	
	3			brn-grn		brn grn	sand w silt					8.6	
				gry grn		gry grn	sand some silt					8.2	
	4											8.4	
												0.5	
	5					gry	f-m sand		~GW wet			1.6	
			40/48						odor or product			41.8	
	6			gry								87	
												194	
	7											188	
												152	
	8												
				EOB									
	9												
	10												
	11												
	12												

* When rock coring, enter rock brokeness.

** Include monitor reading in 6 foot intervals @ borehole. Increase reading frequency if elevated reponse read.

Remarks: ______

Drilling Area Background (ppm): 0.0

Converted to Well: Yes ____ No ✓ Well I.D. #: ______

Tetra Tech NUS, Inc.

BORING LOG

PROJECT NAME: NWIRP Calverton
PROJECT NUMBER: 1610/CTO 004
DRILLING COMPANY: LVS, Inc.
DRILLING RIG: Geoprobe®

BORING No.: FC-SB-111
DATE: 1-24-06
GEOLOGIST: Neb Dedic
DRILLER: Chris O'Shea

Sample No. and Type or RQD	Depth (Ft.) or Run No.	Blows / 6" or RQD (%)	Sample Recovery / Sample Length	Lithology Change (Depth/Ft.) or Screened Interval	MATERIAL DESCRIPTION: Soil Density/ Consistency or Rock Hardness	Color	Material Classification	USCS *	Remarks	PID/FID Reading (ppm): Sample	Sampler BZ	Borehole**	Driller BZ**
						gry	concrete		moist				
	1												
			30/36	grn gry		grn gry	Silty sand		odor on product			114	
	2											138	
						brn	Sand some silt w green stains					162	
	3											149	
				blck		blck	Sand w silt					172	
	4			[illegible]		blck gry						336	
			39/48	grn brn		grn brn	sand tr silt						
	5											394	
				gry grn		gry grn	f-m. sand		~GW wet			407	
	6											444	
												360	
	7											388	
												320	
	8											204	
				EOB									
	9												
	10												
	11												
	12												

* When rock coring, enter rock brokeness.

** Include monitor reading in 6 foot intervals @ borehole. Increase reading frequency if elevated reponse read.

Remarks: ______

Drilling Area Background (ppm): 0.0

Converted to Well: Yes ______ No ✓ Well I.D. #: ______

Tetra Tech NUS, Inc.

BORING LOG

Page ___ of ___

PROJECT NAME:	NWIRP Calverton	BORING No.:	FC-SB-112
PROJECT NUMBER:	1610/CTO 004	DATE:	1-24-06
DRILLING COMPANY:	LVS, Inc.	GEOLOGIST:	Neb Dedic
DRILLING RIG:	Geoprobe®	DRILLER:	Chris O'Shea

Sample No. and Type or RQD	Depth (Ft.) or Run No.	Blows / 6" or RQD (%)	Sample Recovery / Sample Length	Lithology Change (Depth/Ft.) or Screened Interval	MATERIAL DESCRIPTION: Soil Density/ Consistency or Rock Hardness	MATERIAL DESCRIPTION: Color	MATERIAL DESCRIPTION: Material Classification	U S C S *	Remarks	PID/FID Reading (ppm): Sample	PID/FID Reading (ppm): Sampler BZ	PID/FID Reading (ppm): Borehole**	PID/FID Reading (ppm): Driller BZ**
						gry	Concrete		moist				
	1												
						brn grn	silty sand, some clay					0.9	
	2		30/36									2.0	
						brn	sand some silt					1.2	
	3											1.4	
												1.3	
	4											1.2	
							sand tr. silt						
	5											1.2	
			42/48						~GW wet			1.0	
	6					grn grey	f-m sand					0.9	
												0.9	
	7											0.9	
												0.8	
	8											0.8	
				EOB									
	9												
	10												
	11												
	12												

* When rock coring, enter rock brokeness.

** Include monitor reading in 6 foot intervals @ borehole. Increase reading frequency if elevated reponse read.

Remarks: ______

Drilling Area Background (ppm): 0.0

Converted to Well: Yes ____ No ✓ Well I.D. #: ______

Tetra Tech NUS, Inc.

BORING LOG

PROJECT NAME: NWIRP Calverton
PROJECT NUMBER: 1610/CTO 004
DRILLING COMPANY: LVS, Inc.
DRILLING RIG: Geoprobe®

BORING No.: FC-SB-113
DATE: 1-24-06
GEOLOGIST: Neb Dedic
DRILLER: Chris O'Shea

Sample No. and Type or RQD	Depth (Ft.) or Run No.	Blows / 6" or RQD (%)	Sample Recovery / Sample Length	Lithology Change (Depth/Ft.) or Screened Interval	MATERIAL DESCRIPTION: Soil Density/ Consistency or Rock Hardness	Color	Material Classification	USCS *	Remarks	PID/FID Reading (ppm): Sample	Sampler BZ	Borehole**	Driller BZ**
						Drk Brn	Sandy Loam		moist				
	1					Brn	sand w silt					0.5	
			42/48									0.2	
	2											0.1	
												0.0	
	3					tan	sand tr. silt					0.1	
						grn tan			odor of product			81.7	
	4											44.5	
S-1												144	
	5					gry	f-m sand		~GW wet			187	
			44/48									207	
	6											235	
												213	
	7											204	
												304	
	8												
				EOB									
	9												
	10												
	11												
	12												

* When rock coring, enter rock brokeness.

** Include monitor reading in 6 foot intervals @ borehole. Increase reading frequency if elevated reponse read.

Remarks: ______

Drilling Area Background (ppm): 0.0

Converted to Well: Yes ____ No ✓ Well I.D. #: ______

Tetra Tech NUS, Inc.

BORING LOG

Page ___ of ___

PROJECT NAME: NWIRP Calverton
PROJECT NUMBER: 1610/CTO 004
DRILLING COMPANY: LVS, Inc.
DRILLING RIG: Geoprobe®

BORING No.: FC-SB-114
DATE: 1-24-06
GEOLOGIST: Neb Dedic
DRILLER: Chris O'Shea

Sample No. and Type or RQD	Depth (Ft.) or Run No.	Blows / 6" or RQD (%)	Sample Recovery / Sample Length	Lithology Change (Depth/Ft.) or Screened Interval	MATERIAL DESCRIPTION: Soil Density/ Consistency or Rock Hardness	Color	Material Classification	USCS *	Remarks	PID/FID Reading (ppm): Sample	Sampler BZ	Borehole**	Driller BZ**
						DRK BRN	Sandy Loam		Moist				
	1					BRN	Silty sand					0.0	
												0.0	
	2		42/48				sand w silt					0.0	
												0.0	
	3						sand some silt					0.0	
												0.0	
	4						f-m sand tr silt					0.0	
												0.0	
	5								~GW wet			0.0	
						gry	f-m sand					0.0	
	6		40/48	gry								0.0	
												0.0	
	7											0.0	
												0.0	
	8											0.0	
				EOB									
	9												
	10												
	11												
	12												

* When rock coring, enter rock brokeness.

** Include monitor reading in 6 foot intervals @ borehole. Increase reading frequency if elevated reponse read.

Remarks: ______

Drilling Area Background (ppm): 0.0

Converted to Well: Yes ____ No ✓ Well I.D. #: ______

Tetra Tech NUS, Inc.

BORING LOG

Page ___ of ___

PROJECT NAME:	NWIRP Calverton	BORING No.:	FC-SB-115
PROJECT NUMBER:	1610/CTO 004	DATE:	1-24-06
DRILLING COMPANY:	LVS, Inc.	GEOLOGIST:	Neb Dedic
DRILLING RIG:	Geoprobe®	DRILLER:	Chris O'shea

Sample No. and Type or RQD	Depth (Ft.) or Run No.	Blows / 6" or RQD (%)	Sample Recovery / Sample Length	Lithology Change (Depth/Ft.) or Screened Interval	MATERIAL DESCRIPTION: Soil Density/ Consistency or Rock Hardness	Color	Material Classification	USCS *	Remarks	PID/FID Reading (ppm): Sample	Sampler BZ	Borehole**	Driller BZ**
						DRK BRN	sandy Loam		moist				
	1					BRN	sand w silt tr. clay					0.6	
												0.4	
	2		44/48									0.5	
												0.4	
	3						sand tr. silt					0.5	
S-1												0.0	
	4					tan	f-m sand tr. silt					0.1	
				tan									
	5					gry	f-m sand					0.1	
				gry					~GW wet			0.0	
	6		42/48						slight odor			0.0	
												0.0	
	7											0.0	
												0.0	
	8											0.0	
				EOB									
	9												
	10												
	11												
	12												

* When rock coring, enter rock brokeness.

** Include monitor reading in 6 foot intervals @ borehole. Increase reading frequency if elevated reponse read.

Remarks: ______

Drilling Area Background (ppm): 0.0

Converted to Well: Yes ____ No ✓ Well I.D. #: ______

Tetra Tech NUS, Inc.

BORING LOG

PROJECT NAME: NWIRP Calverton
PROJECT NUMBER: 1610/CTO 004
DRILLING COMPANY: LVS, Inc.
DRILLING RIG: Geoprobe®

BORING No.: FC-SB-116
DATE: 1-25-06
GEOLOGIST: Neb Dedic
DRILLER: Chris O'shea

Sample No. and Type or RQD	Depth (Ft.) or Run No.	Blows / 6" or RQD (%)	Sample Recovery / Sample Length	Lithology Change (Depth/Ft.) or Screened Interval	MATERIAL DESCRIPTION: Soil Density/ Consistency or Rock Hardness	Color	Material Classification	USCS *	Remarks	PID/FID Reading (ppm): Sample	Sampler BZ	Borehole**	Driller BZ**
						gry	sandy Loam		moist				
	1					brn	sand some silt						
												0.5	
	2		38/48	brn								0.2	
												0.2	
	3											0.8	
S-1						brn gry	sand w silt					0.8	
	4											0.8	
									~GW wet				
	5			tan		tan	f-m sand tr. silt					2.8	
			42/48	gry		gry	f-m sand					221	
	6											196	
												294	
	7											133	
												181	
	8												
				EOB									
	9												
	10												
	11												
	12												

* When rock coring, enter rock brokeness.

** Include monitor reading in 6 foot intervals @ borehole. Increase reading frequency if elevated reponse read.

Remarks: ______

Drilling Area Background (ppm): 0.0

Converted to Well: Yes ____ No ✓ Well I.D. #: ______

Tetra Tech NUS, Inc.

BORING LOG

Page ___ of ___

PROJECT NAME: NWIRP Calverton
PROJECT NUMBER: 1610/CTO 004
DRILLING COMPANY: LVS, Inc.
DRILLING RIG: Geoprobe®

BORING No.: FC-SB-117
DATE: 1-25-06
GEOLOGIST: Neb Dedic
DRILLER: Chris O'Shea

Sample No. and Type or RQD	Depth (Ft.) or Run No.	Blows / 6" or RQD (%)	Sample Recovery / Sample Length	Lithology Change (Depth/Ft.) or Screened Interval	MATERIAL DESCRIPTION: Soil Density/ Consistency or Rock Hardness	MATERIAL DESCRIPTION: Color	MATERIAL DESCRIPTION: Material Classification	U S C S *	Remarks	PID/FID Reading (ppm): Sample	PID/FID Reading (ppm): Sampler BZ	PID/FID Reading (ppm): Borehole**	PID/FID Reading (ppm): Driller BZ**
						BRK Brn	Sandy Loam		moist			0.0	
	1					brn	Sand some silt + tr. f. gravel		few rocks-fill			0.0	
									material			0.0	
	2		40/48									0.0	
												0.0	
S-1	3											0.0	
												0.0	
	4											0.0	
												0.0	
	5					gry	S-M sand		~GW wet			0.0	
												0.0	
	6		42/48									0.0	
												0.0	
	7											0.0	
												0.0	
	8											0.0	
				EOB									
	9												
	10												
	11												
	12												

* When rock coring, enter rock brokeness.

** Include monitor reading in 6 foot intervals @ borehole. Increase reading frequency if elevated reponse read.

Remarks: ______

Drilling Area Background (ppm): 0.0

Converted to Well: Yes ____ No ✓ Well I.D. #: ______

Tetra Tech NUS, Inc.

BORING LOG

Page ___ of ___

PROJECT NAME: NWIRP Calverton
PROJECT NUMBER: 1610/CTO 004
DRILLING COMPANY: LVS, Inc.
DRILLING RIG: Geoprobe®

BORING No.: FC-SB-118
DATE: 1-25-06
GEOLOGIST: Neb Dedic
DRILLER: ~~[illegible]~~ Chris O'Shea

Sample No. and Type or RQD	Depth (Ft.) or Run No.	Blows / 6" or RQD (%)	Sample Recovery / Sample Length	Lithology Change (Depth/Ft.) or Screened Interval	Soil Density/ Consistency or Rock Hardness	Color	Material Classification	USCS *	Remarks	Sample	Sampler BZ	Borehole**	Driller BZ**
							sandy loam		moist				
	1					brn	sand some silt, tr. f gravel					0.0	
												0.0	
	2		42/48									0.0	
												0.0	
	3					brn gry	sand w silt					0.0	
				brn		brn	sand some silt					0.0	
	4											0.0	
S-1						tan	s-m sand tr. silt					0.0	
	5		40/48	tan					~6' wet			0.0	
						gry						0.0	
	6			gry								0.0	
												0.0	
	7											0.0	
												0.0	
	8											0.0	
				EOB									
	9												
	10												
	11												
	12												

MATERIAL DESCRIPTION; PID/FID Reading (ppm)

* When rock coring, enter rock brokeness.

** Include monitor reading in 6 foot intervals @ borehole. Increase reading frequency if elevated reponse read.

Remarks: ______

Drilling Area Background (ppm): 0.0

Converted to Well: Yes ____ No ✓ Well I.D. #: ______

Tetra Tech NUS, Inc.

BORING LOG

Page ___ of ___

PROJECT NAME: NWIRP Calverton
PROJECT NUMBER: 1610/CTO 004
DRILLING COMPANY: LVS, Inc.
DRILLING RIG: Geoprobe®

BORING No.: FC-SB-119
DATE: 1-25-06
GEOLOGIST: Neb Dedic
DRILLER: Chris O'Shea

Sample No. and Type or RQD	Depth (Ft.) or Run No.	Blows / 6" or RQD (%)	Sample Recovery / Sample Length	Lithology Change (Depth/Ft.) or Screened Interval	MATERIAL DESCRIPTION: Soil Density/ Consistency or Rock Hardness	Color	Material Classification	USCS *	Remarks	PID/FID Reading (ppm): Sample	Sampler BZ	Borehole**	Driller BZ**
						DRK brn	Sandy Loam		moist			0.0	
	1					brn	sand some silt		some fill material			0.0	
									(Rocks)			0.0	
	2		44/48	brn								0.0	
												0.0	
	3											0.0	
						brn grn	silty sand					0.0	
	4			brn		brn	sand some silt					0.0	
						tan	f-m sand					0.0	
	5								~GW wet			0.0	
						gry						0.0	
	6		42/48									0.0	
												0.0	
	7											0.0	
												0.0	
	8											0.0	
				EOB									
	9												
	10												
	11												
	12												

* When rock coring, enter rock brokeness.

** Include monitor reading in 6 foot intervals @ borehole. Increase reading frequency if elevated reponse read.

Remarks: ______

Drilling Area Background (ppm): 0.0

Converted to Well: Yes ____ No ✓ Well I.D. #: ______

Tetra Tech NUS, Inc.

BORING LOG

PROJECT NAME: NWIRP Calverton
PROJECT NUMBER: 1610/CTO 004
DRILLING COMPANY: LVS, Inc.
DRILLING RIG: Geoprobe®

BORING No.: FC-SB-120
DATE: 1-25-06
GEOLOGIST: Neb Dedic
DRILLER: Chris O'Shea

Sample No. and Type or RQD	Depth (Ft.) or Run No.	Blows / 6" or RQD (%)	Sample Recovery / Sample Length	Lithology Change (Depth/Ft.) or Screened Interval	MATERIAL DESCRIPTION: Soil Density/ Consistency or Rock Hardness	Color	Material Classification	USCS *	Remarks	PID/FID Reading (ppm): Sample	Sampler BZ	Borehole**	Driller BZ**
						DRK brn	sandy LOAM		moist				
	1					brn	sand some silt					0.0	
												0.0	
	2											0.0	
			42/48	brn								0.0	
S-1	3					brn grn	silty sand					0.0	
						brn	sand some silt					0.0	
	4			brn								0.0	
				tan		tan	f-m sand					0.0	
	5								~GW wet			0.0	
						tan gry	f-m sand					0.0	
	6		40/48	tan gry								0.0	
												0.0	
	7											0.0	
												0.0	
	8											0.0	
				EOB									
	9												
	10												
	11												
	12												

* When rock coring, enter rock brokeness.

** Include monitor reading in 6 foot intervals @ borehole. Increase reading frequency if elevated reponse read.

Remarks: ______

Drilling Area Background (ppm): 0.0

Converted to Well: Yes ____ No ✓ Well I.D. #: ______

Tetra Tech NUS, Inc.

BORING LOG

PROJECT NAME: NWIRP Calverton
PROJECT NUMBER: 1610/CTO 004
DRILLING COMPANY: LVS, Inc.
DRILLING RIG: Geoprobe®
BORING No.: FC-SB-122
DATE: 1-25-06
GEOLOGIST: Neb Dedic
DRILLER: Chris O'Shea

Sample No. and Type or RQD	Depth (Ft.) or Run No.	Blows / 6" or RQD (%)	Sample Recovery / Sample Length	Lithology Change (Depth/Ft.) or Screened Interval	MATERIAL DESCRIPTION: Soil Density/ Consistency or Rock Hardness	Color	Material Classification	USCS *	Remarks	PID/FID Reading (ppm): Sample	Sampler BZ	Borehole**	Driller BZ**
						gry	concrete						
	1												
				gry/brn		gry/brn	Sand w silt tr. clay		moist			25.4	
	2											37.9	
												21.7	
	3					brn	Sand some silt tr. clay					12.9	
				brn								9.0	
	4											10.1	
						gry/brn	f-m sand, tr. silt		~GW wet			1.5	
	5			gry/brn								1.5	
												1.0	
	6		40/48									0.4	
												0.7	
	7					gry	f-m sand, tr. silt + f. gravel		(coarser than			0.8	
				gry					above)			0.7	
	8											0.5	
				EOB									
	9												
	10												
	11												
	12												

* When rock coring, enter rock brokeness.

** Include monitor reading in 6 foot intervals @ borehole. Increase reading frequency if elevated reponse read.

Remarks: ______

Drilling Area Background (ppm): 0.0

Converted to Well: Yes ____ No ✓ Well I.D. #: ______

Tetra Tech NUS, Inc.

BORING LOG

Page ___ of ___

PROJECT NAME:	NWIRP Calverton	BORING No.:	FC-SB-127
PROJECT NUMBER:	1610/CTO 004	DATE:	1-25-06
DRILLING COMPANY:	LVS, Inc.	GEOLOGIST:	Neb Dedic
DRILLING RIG:	Geoprobe®	DRILLER:	Chris O'Shea

Sample No. and Type or RQD	Depth (Ft.) or Run No.	Blows / 6" or RQD (%)	Sample Recovery / Sample Length	Lithology Change (Depth/Ft.) or Screened Interval	MATERIAL DESCRIPTION: Soil Density/ Consistency or Rock Hardness	Color	Material Classification	USCS *	Remarks	PID/FID Reading (ppm): Sample	Sampler BZ	Borehole**	Driller BZ**
						gry	concrete						
	1												
						brn	sand tr silt + f. gravel		moist			6.6	
	2											0.0	
			31/36	brn								0.0	
	3											0.0	
						grn gry	sand w silt		grn-grayish			12.2	
	4					brn	f. sand tr. silt + m. sand					2.8	
				brn								0.0	
	5					gry	f-m sand		~GW wet			0.0	
				gry								0.0	
	6		42/48									0.0	
												0.0	
	7											0.0	
												0.0	
	8											0.0	
				EOB									
	9												
	10												
	11												
	12												

* When rock coring, enter rock brokeness.

** Include monitor reading in 6 foot intervals @ borehole. Increase reading frequency if elevated reponse read.

Remarks: ______________________

Drilling Area Background (ppm): 0.0

Converted to Well: Yes ______ No ✓ Well I.D. #: ______________________

Tetra Tech NUS, Inc.

BORING LOG

Page ___ of ___

PROJECT NAME: NWIRP Calverton
PROJECT NUMBER: 1610/CTO 004
DRILLING COMPANY: LVS, Inc.
DRILLING RIG: Geoprobe®

BORING No.: FC-SB-123
DATE: 1-25-06
GEOLOGIST: Neb Dedic
DRILLER: Chris O'Shea

Sample No. and Type or RQD	Depth (Ft.) or Run No.	Blows / 6" or RQD (%)	Sample Recovery / Sample Length	Lithology Change (Depth/Ft.) or Screened Interval	MATERIAL DESCRIPTION: Soil Density/ Consistency or Rock Hardness	Color	Material Classification	USCS *	Remarks	PID/FID Reading (ppm): Sample	Sampler BZ	Borehole**	Driller BZ**
						gry	concrete						
	1												
						brn	sand w silt tr. clay		moist		0.1		
	2		30/36								0.3		
				brn							0.2		
	3										0.1		
							sand some silt				0.0		
	4										0.0		
						tan	f-m sand tr silt						
	5								~GW wet		0.0		
				tan							0.0		
	6		36/48								0.0		
											0.0		
	7					gry					0.0		
				gry							0.0		
	8										0.0		
				EOB									
	9												
	10												
	11												
	12												

* When rock coring, enter rock brokeness.

** Include monitor reading in 6 foot intervals @ borehole. Increase reading frequency if elevated reponse read.

Remarks: ______________________

Drilling Area Background (ppm): 0.0

Converted to Well: Yes ____ No ✓ Well I.D. #: ____

Tetra Tech NUS, Inc.

BORING LOG

PROJECT NAME: NWIRP Calverton
PROJECT NUMBER: 1610/CTO 004
DRILLING COMPANY: LVS, Inc.
DRILLING RIG: Geoprobe®
BORING No.: FC-SB-124
DATE: 1-25-06
GEOLOGIST: Neb Dedic
DRILLER: Chris O'Shea

Sample No. and Type or RQD	Depth (Ft.) or Run No.	Blows / 6" or RQD (%)	Sample Recovery / Sample Length	Lithology Change (Depth/Ft.) or Screened Interval	Soil Density/ Consistency or Rock Hardness (MATERIAL DESCRIPTION)	Color	Material Classification	USCS*	Remarks	PID/FID Reading (ppm) Sample	Sampler BZ	Borehole**	Driller BZ**
						gry	concrete						
	1												
			30/36			brn	Sand & silt tr. clay		moist			0.0	
	2											0.0	
												0.0	
	3											0.0	
							Sand some silt tr. clay					0.0	
	4											0.0	
			40/48			brn tan	f-m sand tr. silt & f-gravel					0.0	
	5			brn tan					~GW wet			0.0	
												0.0	
	6											0.0	
						gry	f-m sand, tr. f. gravel					0.0	
	7			gry								0.0	
												0.0	
	8											0.0	
				EOB									
	9												
	10												
	11												
	12												

* When rock coring, enter rock brokeness.

** Include monitor reading in 6 foot intervals @ borehole. Increase reading frequency if elevated reponse read.

Remarks: ______

Drilling Area Background (ppm): 0.0

Converted to Well: Yes ____ No ✓ Well I.D. #: ______

Tetra Tech NUS, Inc.

BORING LOG

PROJECT NAME: NWIRP Calverton
PROJECT NUMBER: 1610/CTO 004
DRILLING COMPANY: LVS, Inc.
DRILLING RIG: Geoprobe®

BORING No.: FC-SB-125
DATE: 1-25-06
GEOLOGIST: Neb Dedic
DRILLER: Chris O'Shea

Sample No. and Type or RQD	Depth (Ft.) or Run No.	Blows / 6" or RQD (%)	Sample Recovery / Sample Length	Lithology Change (Depth/Ft.) or Screened Interval	Soil Density/ Consistency or Rock Hardness	Color	Material Classification	USCS *	Remarks	PID/FID Reading (ppm) Sample	Sampler BZ	Borehole**	Driller BZ**
						DRK BRN	Sandy loam		moist				
	1					tan	f-m sand, tr. f. gravel						
												0.0	
	2		38/48									0.0	
				tan								0.0	
	3											1.4	
									odor of product			42.1	
	4			grn gry		grn gry	f-m sand, some silt		grn-grayish			44.3	
						tan			~GW wet			4.4	
	5			tan								28	
						grn gry	f-m sand some silt		grn-grayish			64.6	
	6		46/48									96.4	
												182	
	7											306	
						grn gry	f-m sand, tr. silt		(coarser than			268	
	8								above)			204	
				EOB									
	9												
	10												
	11												
	12												

* When rock coring, enter rock brokeness.

** Include monitor reading in 6 foot intervals @ borehole. Increase reading frequency if elevated reponse read.

Remarks: ______

Drilling Area Background (ppm): 0.0

Converted to Well: Yes ____ No ✓ Well I.D. #: ______

Tetra Tech NUS, Inc.

BORING LOG

Page ___ of ___

PROJECT NAME: NWIRP Calverton
PROJECT NUMBER: 1610/CTO 004
DRILLING COMPANY: LVS, Inc.
DRILLING RIG: Geoprobe®

BORING No.: FC-SB-126
DATE: 1-25-06
GEOLOGIST: Neb Dedic
DRILLER: Chris O'Shea

Sample No. and Type or RQD	Depth (Ft.) or Run No.	Blows / 6" or RQD (%)	Sample Recovery / Sample Length	Lithology Change (Depth/Ft.) or Screened Interval	MATERIAL DESCRIPTION: Soil Density/ Consistency or Rock Hardness	Color	Material Classification	U S C S *	Remarks	PID/FID Reading (ppm): Sample	Sampler BZ	Borehole**	Driller BZ**
						DRK brn	Sandy Loam		moist				
	1					brn	sand some silt					1.3	
			43/48						slight odor			31.2	
	2								on product			5.9	
				grn gry		grn gry	sand w silt					2.4	
	3			gry grn		gry grn	sand some silt					12.5	
									odor			67.5	
	4											179	
												185	
	5											295	
									~GW wet			360	
	6		42/48	gry		gry	f-m sand					853	
												607	
	7											695	
												1008	
	8											389	
				EOB									
	9												
	10												
	11												
	12												

* When rock coring, enter rock brokeness.

** Include monitor reading in 6 foot intervals @ borehole. Increase reading frequency if elevated reponse read.

Remarks: ______

Drilling Area Background (ppm): 0.0

Converted to Well: Yes ______ No ✓ Well I.D. #: ______

ATTACHMENT B

CHAIN-OF-CUSTODY FORMS

C6A260253

[redacted]

Chain of Custody Record

STL-4124 (0901)

SEVERN TRENT **STL**®

Severn Trent Laboratories, Inc.

Client	Project Manager	Date	Chain of Custody Number
TETRA TECH NUS, INC.	DAVID BRAYACK	1/25/06	273670

Address	Telephone Number (Area Code)/Fax Number	Lab Number	Page 1 of 2
661 ANDERSEN DRIVE	(412) 921-7090 / (412) 921-4040		

City	State	Zip Code	Site Contact	Lab Contact
PITTSBURGH	PA	15220	NEB DEDIC	VERONICA BORTOT

Project Name and Location (State)	Carrier/Waybill Number
CALVERTON SITE 6A (NY)	FEDEX

Contract/Purchase Order/Quote No.

Analysis (Attach list if more space is needed)

Sample I.D. No. and Description (Containers for each sample may be combined on one line)	Date	Time	Air	Aqueous	Sed.	Soil		Unpres.	H2SO4	HNO3	HCl	NaOH	ZnAc/NaOH		PCB	Special Instructions/Conditions of Receipt
FC-SB-102-3545	1/24/06	10:52				X									X	
FC-SB-104-0102	1/24/06	11:10				X									X	
FC-SB-106-0203	1/24/06	11:31				X									X	
FC-SB-108-2535	1/24/06	11:46				X									X	
FC-SS-102	1/24/06	09:10				X									X	
FC-SS-104	1/24/06	09:13				X									X	
FC-SS-105	1/24/06	12:51				X									X	
FC-SB-103-3545	1/24/06	09:30				X									X	
FC-SB-117-0203	1/25/06	08:59				X									X	
FC-SB-119-3545	1/25/06	09:27				X									X	MS/MSD
FC-SB-102-0607	1/25/06	10:23				X									X	
FC-SB-104-0607	1/25/06	10:11				X									X	

Possible Hazard Identification
☐ Non-Hazard ☐ Flammable ☐ Skin Irritant ☐ Poison B ☐ Unknown

Sample Disposal
☐ Return To Client ☐ Disposal By Lab ☐ Archive For ______ Months (A fee may be assessed if samples are retained longer than 1 month)

Turn Around Time Required
☐ 24 Hours ☐ 48 Hours ☒ 7 Days ☐ 14 Days ☐ 21 Days ☐ Other______

QC Requirements (Specify)

	Date	Time		Date	Time
1. Relinquished By: Neb Dedic	1-25-06	1715	1. Received By: J. Park	01-26-06	0910
2. Relinquished By			2. Received By		
3. Relinquished By			3. Received By		

Comments

(1 - 55)

DISTRIBUTION: WHITE - Returned to Client with Report; CANARY - Stays with the Sample; PINK - Field Copy

C6A260253

Chain of Custody Record

SEVERN TRENT **STL**®
Severn Trent Laboratories, Inc.

STL-4124 (0901)

Client: TETRA TECH NUS, INC.
Project Manager: DAVID BRAYACK
Date: 1/25/06
Chain of Custody Number: 273669

Address: 661 ANDERSEN DRIVE
Telephone Number (Area Code)/Fax Number: (412) 921-7090 / (412) 921-4040
Lab Number:
Page 2 **of** 2

City: PITTSBURGH **State:** PA **Zip Code:** 15220
Site Contact: NEB DEDIC
Lab Contact: VERONICA BORTOT

Project Name and Location (State): CALVERTON SITE 6A (NY)
Carrier/Waybill Number: FED EX
Contract/Purchase Order/Quote No.:

Analysis (Attach list if more space is needed)

Special Instructions/ Conditions of Receipt

Sample I.D. No. and Description (Containers for each sample may be combined on one line)	Date	Time	Air	Aqueous	Sed.	Soil	Unpres.	H2SO4	HNO3	HCl	NaOH	ZnAc/ NaOH	PCB
FC-SB-106-0607	1/25/06	10:00				X							X
FC-SB-108-0607	1/25/06	09:48				X							X
FC-SS-109	1/25/06	08:09				X							X
FC-SS-121	1/25/06	08:11				X							X
FC-SS-128	1/25/06	13:40				X							X
DUP-012506-02	1/25/06	13:45				X							X
FC-SB-115-2535	1/24/06	14:32				X							X
FC-SB-114-0102	1/24/06	14:44				X							X
DUP-012406-01	1/24/06	15:00				X							X
FC-SB-113-3545	1/24/06	15:00				X							X
FB-012506	1/25/06			X									X

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Possible Hazard Identification: ☐ Non-Hazard ☐ Flammable ☐ Skin Irritant ☐ Poison B ☐ Unknown

Sample Disposal: ☐ Return To Client ☐ Disposal By Lab ☐ Archive For ____ Months (A fee may be assessed if samples are retained longer than 1 month)

Turn Around Time Required: ☐ 24 Hours ☐ 48 Hours ☒ 7 Days ☐ 14 Days ☐ 21 Days ☐ Other____

QC Requirements (Specify):

1. Relinquished By: Neb Dedic	Date: 1-25-06	Time: 1715	1. Received By: [signature]	Date: 01-26-06	Time: 0910
2. Relinquished By	Date	Time	2. Received By	Date	Time
3. Relinquished By	Date	Time	3. Received By	Date	Time

Comments

(1 - 55)

DISTRIBUTION: WHITE - Returned to Client with Report; CANARY - Stays with the Sample; PINK - Field Copy

ATTACHMENT C

ANALYTICAL LABORATORY DATA

SAMPLE SUMMARY

C6A260253

WO #	SAMPLE#	CLIENT SAMPLE ID	SAMPLED DATE	SAMP TIME
HWCD1	001	FC-SB-102-3545	01/24/06	10:52
HWCD7	002	FC-SB-104-0102	01/24/06	11:10
HWCEC	003	FC-SB-106-0203	01/24/06	11:31
HWCEF	004	FC-SB-108-2535	01/24/06	11:46
HWCEH	005	FC-SS-102	01/24/06	09:10
HWCEL	006	FC-SS-104	01/24/06	09:13
HWCEM	007	FC-SS-105	01/24/06	12:51
HWCEQ	008	FC-SB-103-3545	01/24/06	09:30
HWCEV	009	FC-SB-117-0203	01/25/06	08:59
HWCE1	010	FC-SB-119-3545	01/25/06	09:27
HWCE7	011	FC-SB-102-0607	01/25/06	10:23
HWCE9	012	FC-SB-104-0607	01/25/06	10:11
HWCFA	013	FC-SB-106-0607	01/25/06	10:00
HWCFG	014	FC-SB-108-0607	01/25/06	09:48
HWCFJ	015	FC-SS-109	01/25/06	08:09
HWCFK	016	FC-SS-121	01/25/06	08:11
HWCFM	017	FC-SS-128	01/25/06	13:40
HWCFQ	018	DUP-012506-02	01/25/06	13:45
HWCFV	019	FC-SB-115-2535	01/24/06	14:32
HWCF0	020	FC-SB-114-0102	01/24/06	14:44
HWCF1	021	DUP-012406-01	01/24/06	15:00
HWCF5	022	FC-SB-113-3545	01/24/06	15:00
HWCF6	023	FB-012506	01/25/06	

NOTE(S):

- The analytical results of the samples listed above are presented on the following pages.
- All calculations are performed before rounding to avoid round-off errors in calculated results.
- Results noted as "ND" were not detected at or above the stated limit.
- This report must not be reproduced, except in full, without the written approval of the laboratory.
- Results for the following parameters are never reported on a dry weight basis: color, corrosivity, density, flashpoint, ignitability, layers, odor, paint filter test, pH, porosity pressure, reactivity, redox potential, specific gravity, spot tests, solids, solubility, temperature, viscosity, and weight.

Tetra Tech NUS, Inc

Client Sample ID: FC-SB-104-0102

GC Semivolatiles

Lot-Sample #...:	C6A260253-002	**Work Order #...:**	HWCD71AC	**Matrix.........:**	SOLID
Date Sampled...:	01/24/06	**Date Received..:**	01/26/06	**MS Run #.......:**	6027021
Prep Date......:	01/27/06	**Analysis Date..:**	01/28/06		
Prep Batch #...:	6027037	**Analysis Time..:**	11:45		
Dilution Factor:	1	**Initial Wgt/Vol:**	15 g	**Final Wgt/Vol..:**	5 mL
% Moisture.....:	10	**Analyst ID.....:**	402360	**Instrument ID..:**	S/T
		Method.........:	SW846 8082		

PARAMETER	RESULT	REPORTING LIMIT	UNITS	MDL
Aroclor 1016	ND	37	ug/kg	29
Aroclor 1221	ND	37	ug/kg	14
Aroclor 1232	ND	37	ug/kg	18
Aroclor 1242	ND	37	ug/kg	12
Aroclor 1248	ND	37	ug/kg	13
Aroclor 1254	ND	37	ug/kg	4.9
Aroclor 1260	**94**	**37**	**ug/kg**	**4.1**

SURROGATE	PERCENT RECOVERY	RECOVERY LIMITS
Tetrachloro-m-xylene	78	(31 - 127)
Decachlorobiphenyl	88	(23 - 141)

NOTE(S):

Results and reporting limits have been adjusted for dry weight.

Tetra Tech NUS, Inc

Client Sample ID: FC-SB-106-0203

GC Semivolatiles

Lot-Sample #...:	C6A260253-003	**Work Order #...:**	HWCEC1AC	**Matrix.........:**	SOLID
Date Sampled...:	01/24/06	**Date Received..:**	01/26/06	**MS Run #.......:**	6027021
Prep Date......:	01/27/06	**Analysis Date..:**	01/28/06		
Prep Batch #...:	6027037	**Analysis Time..:**	12:06		
Dilution Factor:	1	**Initial Wgt/Vol:**	15 g	**Final Wgt/Vol..:**	5 mL
% Moisture.....:	7.4	**Analyst ID.....:**	402360	**Instrument ID..:**	S/T
		Method.........:	SW846 8082		

PARAMETER	RESULT	REPORTING LIMIT	UNITS	MDL
Aroclor 1016	ND	36	ug/kg	29
Aroclor 1221	ND	36	ug/kg	14
Aroclor 1232	ND	36	ug/kg	17
Aroclor 1242	ND	36	ug/kg	12
Aroclor 1248	ND	36	ug/kg	13
Aroclor 1254	ND	36	ug/kg	4.8
Aroclor 1260	ND	36	ug/kg	4.0

SURROGATE	PERCENT RECOVERY	RECOVERY LIMITS
Tetrachloro-m-xylene	80	(31 - 127)
Decachlorobiphenyl	88	(23 - 141)

NOTE(S):

Results and reporting limits have been adjusted for dry weight.

Tetra Tech NUS, Inc

Client Sample ID: FC-SB-108-2535

GC Semivolatiles

Lot-Sample #...:	C6A260253-004	**Work Order #...:**	HWCEF1AC	**Matrix.........:**	SOLID
Date Sampled...:	01/24/06	**Date Received..:**	01/26/06	**MS Run #.......:**	6027021
Prep Date......:	01/27/06	**Analysis Date..:**	01/28/06		
Prep Batch #...:	6027037	**Analysis Time..:**	12:27		
Dilution Factor:	1	**Initial Wgt/Vol:**	15 g	**Final Wgt/Vol..:**	5 mL
% Moisture.....:	4.9	**Analyst ID.....:**	402360	**Instrument ID..:**	S/T
		Method.........:	SW846 8082		

PARAMETER	RESULT	REPORTING LIMIT	UNITS	MDL
Aroclor 1016	ND	35	ug/kg	28
Aroclor 1221	ND	35	ug/kg	13
Aroclor 1232	ND	35	ug/kg	17
Aroclor 1242	ND	35	ug/kg	12
Aroclor 1248	ND	35	ug/kg	13
Aroclor 1254	ND	35	ug/kg	4.6
Aroclor 1260	ND	35	ug/kg	3.9

SURROGATE	PERCENT RECOVERY	RECOVERY LIMITS
Tetrachloro-m-xylene	85	(31 - 127)
Decachlorobiphenyl	94	(23 - 141)

NOTE(S):

Results and reporting limits have been adjusted for dry weight.

Tetra Tech NUS, Inc

Client Sample ID: FC-SS-102

GC Semivolatiles

Lot-Sample #...:	C6A260253-005	**Work Order #...:**	HWCEH1AC	**Matrix.........:**	SOLID
Date Sampled...:	01/24/06	**Date Received..:**	01/26/06	**MS Run #.......:**	6027021
Prep Date......:	01/27/06	**Analysis Date..:**	01/31/06		
Prep Batch #...:	6027037	**Analysis Time..:**	08:50		
Dilution Factor:	400	**Initial Wgt/Vol:**	15 g	**Final Wgt/Vol..:**	5 mL
% Moisture.....:	14	**Analyst ID.....:**	402360	**Instrument ID..:**	S/T
		Method.........:	SW846 8082		

PARAMETER	RESULT	REPORTING LIMIT	UNITS	MDL
Aroclor 1016	ND	15000	ug/kg	12000
Aroclor 1221	ND	15000	ug/kg	5900
Aroclor 1232	ND	15000	ug/kg	7300
Aroclor 1242	ND	15000	ug/kg	5100
Aroclor 1248	ND	15000	ug/kg	5600
Aroclor 1254	ND	15000	ug/kg	2100
Aroclor 1260	**330000**	**15000**	**ug/kg**	**1700**

SURROGATE	PERCENT RECOVERY	RECOVERY LIMITS
Tetrachloro-m-xylene	NC,DIL	(31 - 127)
Decachlorobiphenyl	NC,DIL	(23 - 141)

NOTE(S):

NC The recovery and/or RPD were not calculated.

DIL The concentration is estimated or not reported due to dilution or the presence of interfering analytes.

Results and reporting limits have been adjusted for dry weight.

Tetra Tech NUS, Inc

Client Sample ID: FC-SS-104

GC Semivolatiles

Lot-Sample #...:	C6A260253-006	**Work Order #...:**	HWCEL1AC	**Matrix.........:**	SOLID
Date Sampled...:	01/24/06	**Date Received..:**	01/26/06	**MS Run #.......:**	6027021
Prep Date......:	01/27/06	**Analysis Date..:**	01/30/06		
Prep Batch #...:	6027037	**Analysis Time..:**	12:58		
Dilution Factor:	3	**Initial Wgt/Vol:**	15 g	**Final Wgt/Vol..:**	5 mL
% Moisture.....:	13	**Analyst ID.....:**	402360	**Instrument ID..:**	S/T
		Method.........:	SW846 8082		

PARAMETER	RESULT	REPORTING LIMIT	UNITS	MDL
Aroclor 1016	ND	110	ug/kg	91
Aroclor 1221	ND	110	ug/kg	44
Aroclor 1232	ND	110	ug/kg	54
Aroclor 1242	ND	110	ug/kg	38
Aroclor 1248	ND	110	ug/kg	42
Aroclor 1254	ND	110	ug/kg	15
Aroclor 1260	**3100**	**110**	**ug/kg**	**13**

SURROGATE	PERCENT RECOVERY	RECOVERY LIMITS
Tetrachloro-m-xylene	93	(31 - 127)
Decachlorobiphenyl	114	(23 - 141)

NOTE(S):

Results and reporting limits have been adjusted for dry weight.

Tetra Tech NUS, Inc

Client Sample ID: FC-SS-105

GC Semivolatiles

Lot-Sample #...:	C6A260253-007	**Work Order #...:**	HWCEM1AC	**Matrix.........:**	SOLID
Date Sampled...:	01/24/06	**Date Received..:**	01/26/06	**MS Run #.......:**	6027021
Prep Date......:	01/27/06	**Analysis Date..:**	01/30/06		
Prep Batch #...:	6027037	**Analysis Time..:**	13:20		
Dilution Factor:	2	**Initial Wgt/Vol:**	15 g	**Final Wgt/Vol..:**	5 mL
% Moisture.....:	15	**Analyst ID.....:**	402360	**Instrument ID..:**	S/T
		Method.........:	SW846 8082		

PARAMETER	RESULT	REPORTING LIMIT	UNITS	MDL
Aroclor 1016	ND	78	ug/kg	62
Aroclor 1221	ND	78	ug/kg	30
Aroclor 1232	ND	78	ug/kg	37
Aroclor 1242	ND	78	ug/kg	26
Aroclor 1248	ND	78	ug/kg	28
Aroclor 1254	ND	78	ug/kg	10
Aroclor 1260	**2100**	**78**	**ug/kg**	**8.7**

SURROGATE	PERCENT RECOVERY	RECOVERY LIMITS
Tetrachloro-m-xylene	107	(31 - 127)
Decachlorobiphenyl	122	(23 - 141)

NOTE(S):

Results and reporting limits have been adjusted for dry weight.

Tetra Tech NUS, Inc

Client Sample ID: FC-SB-103-3545

GC Semivolatiles

Lot-Sample #...:	C6A260253-008	**Work Order #...:**	HWCEQ1AC	**Matrix.........:**	SOLID
Date Sampled...:	01/24/06	**Date Received..:**	01/26/06	**MS Run #.......:**	6027021
Prep Date......:	01/27/06	**Analysis Date..:**	01/28/06		
Prep Batch #...:	6027037	**Analysis Time..:**	16:02		
Dilution Factor:	1	**Initial Wgt/Vol:**	15 g	**Final Wgt/Vol..:**	5 mL
% Moisture.....:	9.8	**Analyst ID.....:**	402360	**Instrument ID..:**	S/T
		Method.........:	SW846 8082		

PARAMETER	RESULT	REPORTING LIMIT	UNITS	MDL
Aroclor 1016	ND	37	ug/kg	29
Aroclor 1221	ND	37	ug/kg	14
Aroclor 1232	ND	37	ug/kg	17
Aroclor 1242	ND	37	ug/kg	12
Aroclor 1248	ND	37	ug/kg	13
Aroclor 1254	ND	37	ug/kg	4.9
Aroclor 1260	**410**	**37**	**ug/kg**	**4.1**

SURROGATE	PERCENT RECOVERY	RECOVERY LIMITS
Tetrachloro-m-xylene	61	(31 - 127)
Decachlorobiphenyl	111	(23 - 141)

NOTE(S):

Results and reporting limits have been adjusted for dry weight.

Tetra Tech NUS, Inc

Client Sample ID: FC-SB-117-0203

GC Semivolatiles

Lot-Sample #...:	C6A260253-009	**Work Order #...:**	HWCEV1AC	**Matrix.........:**	SOLID
Date Sampled...:	01/25/06	**Date Received..:**	01/26/06	**MS Run #.......:**	6027021
Prep Date......:	01/27/06	**Analysis Date..:**	01/28/06		
Prep Batch #...:	6027037	**Analysis Time..:**	16:24		
Dilution Factor:	1	**Initial Wgt/Vol:**	15 g	**Final Wgt/Vol..:**	5 mL
% Moisture.....:	7.5	**Analyst ID.....:**	402360	**Instrument ID..:**	S/T
		Method.........:	SW846 8082		

PARAMETER	RESULT	REPORTING LIMIT	UNITS	MDL
Aroclor 1016	ND	36	ug/kg	29
Aroclor 1221	ND	36	ug/kg	14
Aroclor 1232	ND	36	ug/kg	17
Aroclor 1242	ND	36	ug/kg	12
Aroclor 1248	ND	36	ug/kg	13
Aroclor 1254	ND	36	ug/kg	4.8
Aroclor 1260	ND	36	ug/kg	4.0

SURROGATE	PERCENT RECOVERY	RECOVERY LIMITS
Tetrachloro-m-xylene	85	(31 - 127)
Decachlorobiphenyl	97	(23 - 141)

NOTE(S):

Results and reporting limits have been adjusted for dry weight.

Tetra Tech NUS, Inc

Client Sample ID: FC-SB-119-3545

GC Semivolatiles

Lot-Sample #...:	C6A260253-010	**Work Order #...:**	HWCE11AC	**Matrix.........:**	SOLID
Date Sampled...:	01/25/06	**Date Received..:**	01/26/06	**MS Run #.......:**	6027021
Prep Date......:	01/27/06	**Analysis Date..:**	01/28/06		
Prep Batch #...:	6027037	**Analysis Time..:**	16:45		
Dilution Factor:	1	**Initial Wgt/Vol:**	15 g	**Final Wgt/Vol..:**	5 mL
% Moisture.....:	9.0	**Analyst ID.....:**	402360	**Instrument ID..:**	S/T
		Method.........:	SW846 8082		

PARAMETER	RESULT	REPORTING LIMIT	UNITS	MDL
Aroclor 1016	ND	36	ug/kg	29
Aroclor 1221	ND	36	ug/kg	14
Aroclor 1232	ND	36	ug/kg	17
Aroclor 1242	ND	36	ug/kg	12
Aroclor 1248	ND	36	ug/kg	13
Aroclor 1254	ND	36	ug/kg	4.9
Aroclor 1260	ND	36	ug/kg	4.0

SURROGATE	PERCENT RECOVERY	RECOVERY LIMITS
Tetrachloro-m-xylene	83	(31 - 127)
Decachlorobiphenyl	85	(23 - 141)

NOTE(S):

Results and reporting limits have been adjusted for dry weight.

Tetra Tech NUS, Inc

Client Sample ID: FC-SB-102-0607

GC Semivolatiles

Lot-Sample #...:	C6A260253-011	**Work Order #...:**	HWCE71AC	**Matrix.........:**	SOLID
Date Sampled...:	01/25/06	**Date Received..:**	01/26/06	**MS Run #.......:**	6027021
Prep Date......:	01/27/06	**Analysis Date..:**	01/30/06		
Prep Batch #...:	6027037	**Analysis Time..:**	13:41		
Dilution Factor:	2	**Initial Wgt/Vol:**	15 g	**Final Wgt/Vol..:**	5 mL
% Moisture.....:	12	**Analyst ID.....:**	402360	**Instrument ID..:**	S/T
		Method.........:	SW846 8082		

PARAMETER	RESULT	REPORTING LIMIT	UNITS	MDL
Aroclor 1016	ND	75	ug/kg	60
Aroclor 1221	ND	75	ug/kg	29
Aroclor 1232	ND	75	ug/kg	36
Aroclor 1242	ND	75	ug/kg	25
Aroclor 1248	ND	75	ug/kg	28
Aroclor 1254	ND	75	ug/kg	10
Aroclor 1260	**2100**	**75**	**ug/kg**	**8.4**

SURROGATE	PERCENT RECOVERY	RECOVERY LIMITS
Tetrachloro-m-xylene	77	(31 - 127)
Decachlorobiphenyl	133	(23 - 141)

NOTE(S):

Results and reporting limits have been adjusted for dry weight.

Tetra Tech NUS, Inc

Client Sample ID: FC-SB-104-0607

GC Semivolatiles

Lot-Sample #...:	C6A260253-012	**Work Order #...:**	HWCE91AC	**Matrix.........:**	SOLID
Date Sampled...:	01/25/06	**Date Received..:**	01/26/06	**MS Run #.......:**	6027021
Prep Date......:	01/27/06	**Analysis Date..:**	01/30/06		
Prep Batch #...:	6027037	**Analysis Time..:**	14:03		
Dilution Factor:	30	**Initial Wgt/Vol:**	15 g	**Final Wgt/Vol..:**	5 mL
% Moisture.....:	13	**Analyst ID.....:**	402360	**Instrument ID..:**	S/T
		Method.........:	SW846 8082		

PARAMETER	RESULT	REPORTING LIMIT	UNITS	MDL
Aroclor 1016	ND	1100	ug/kg	910
Aroclor 1221	ND	1100	ug/kg	440
Aroclor 1232	ND	1100	ug/kg	540
Aroclor 1242	ND	1100	ug/kg	380
Aroclor 1248	ND	1100	ug/kg	420
Aroclor 1254	ND	1100	ug/kg	150
Aroclor 1260	**17000**	**1100**	**ug/kg**	**130**

SURROGATE	PERCENT RECOVERY	RECOVERY LIMITS
Tetrachloro-m-xylene	NC,DIL	(31 - 127)
Decachlorobiphenyl	NC,DIL	(23 - 141)

NOTE(S):

NC The recovery and/or RPD were not calculated.

DIL The concentration is estimated or not reported due to dilution or the presence of interfering analytes.

Results and reporting limits have been adjusted for dry weight.

Tetra Tech NUS, Inc

Client Sample ID: FC-SB-106-0607

GC Semivolatiles

Lot-Sample #...:	C6A260253-013	**Work Order #...:**	HWCFA1AC	**Matrix.........:**	SOLID
Date Sampled...:	01/25/06	**Date Received..:**	01/26/06	**MS Run #.......:**	6027021
Prep Date......:	01/27/06	**Analysis Date..:**	01/28/06		
Prep Batch #...:	6027037	**Analysis Time..:**	18:33		
Dilution Factor:	1	**Initial Wgt/Vol:**	15 g	**Final Wgt/Vol..:**	5 mL
% Moisture.....:	11	**Analyst ID.....:**	402360	**Instrument ID..:**	S/T
		Method.........:	SW846 8082		

PARAMETER	RESULT	REPORTING LIMIT	UNITS	MDL
Aroclor 1016	ND	37	ug/kg	30
Aroclor 1221	ND	37	ug/kg	14
Aroclor 1232	ND	37	ug/kg	18
Aroclor 1242	ND	37	ug/kg	13
Aroclor 1248	ND	37	ug/kg	14
Aroclor 1254	ND	37	ug/kg	5.0
Aroclor 1260	ND	37	ug/kg	4.1

SURROGATE	PERCENT RECOVERY	RECOVERY LIMITS
Tetrachloro-m-xylene	80	(31 - 127)
Decachlorobiphenyl	87	(23 - 141)

NOTE(S):

Results and reporting limits have been adjusted for dry weight.

Tetra Tech NUS, Inc

Client Sample ID: FC-SB-108-0607

GC Semivolatiles

Lot-Sample #...:	C6A260253-014	**Work Order #...:**	HWCFG1AC	**Matrix.........:**	SOLID
Date Sampled...:	01/25/06	**Date Received..:**	01/26/06	**MS Run #.......:**	6027021
Prep Date......:	01/27/06	**Analysis Date..:**	01/28/06		
Prep Batch #...:	6027037	**Analysis Time..:**	18:54		
Dilution Factor:	1	**Initial Wgt/Vol:**	15 g	**Final Wgt/Vol..:**	5 mL
% Moisture.....:	14	**Analyst ID.....:**	402360	**Instrument ID..:**	S/T
		Method.........:	SW846 8082		

PARAMETER	RESULT	REPORTING LIMIT	UNITS	MDL
Aroclor 1016	ND	38	ug/kg	31
Aroclor 1221	ND	38	ug/kg	15
Aroclor 1232	ND	38	ug/kg	18
Aroclor 1242	ND	38	ug/kg	13
Aroclor 1248	ND	38	ug/kg	14
Aroclor 1254	ND	38	ug/kg	5.1
Aroclor 1260	ND	38	ug/kg	4.3

SURROGATE	PERCENT RECOVERY	RECOVERY LIMITS
Tetrachloro-m-xylene	84	(31 - 127)
Decachlorobiphenyl	94	(23 - 141)

NOTE(S):

Results and reporting limits have been adjusted for dry weight.

Tetra Tech NUS, Inc

Client Sample ID: FC-SS-109

GC Semivolatiles

Lot-Sample #...:	C6A260253-015	**Work Order #...:**	HWCFJ1AC	**Matrix.........:**	SOLID
Date Sampled...:	01/25/06	**Date Received..:**	01/26/06	**MS Run #.......:**	6027021
Prep Date......:	01/27/06	**Analysis Date..:**	01/28/06		
Prep Batch #...:	6027037	**Analysis Time..:**	19:16		
Dilution Factor:	1	**Initial Wgt/Vol:**	15 g	**Final Wgt/Vol..:**	5 mL
% Moisture.....:	23	**Analyst ID.....:**	402360	**Instrument ID..:**	S/T
		Method.........:	SW846 8082		

PARAMETER	RESULT	REPORTING LIMIT	UNITS	MDL
Aroclor 1016	ND	43	ug/kg	34
Aroclor 1221	ND	43	ug/kg	17
Aroclor 1232	ND	43	ug/kg	20
Aroclor 1242	ND	43	ug/kg	14
Aroclor 1248	ND	43	ug/kg	16
Aroclor 1254	ND	43	ug/kg	5.7
Aroclor 1260	**91**	**43**	**ug/kg**	**4.8**

SURROGATE	PERCENT RECOVERY	RECOVERY LIMITS
Tetrachloro-m-xylene	82	(31 - 127)
Decachlorobiphenyl	92	(23 - 141)

NOTE(S):

Results and reporting limits have been adjusted for dry weight.

Tetra Tech NUS, Inc

Client Sample ID: FC-SS-121

GC Semivolatiles

Lot-Sample #...:	C6A260253-016	**Work Order #...:**	HWCFK1AC	**Matrix.........:**	SOLID
Date Sampled...:	01/25/06	**Date Received..:**	01/26/06	**MS Run #.......:**	6027021
Prep Date......:	01/27/06	**Analysis Date..:**	01/28/06		
Prep Batch #...:	6027037	**Analysis Time..:**	19:38		
Dilution Factor:	1	**Initial Wgt/Vol:**	15 g	**Final Wgt/Vol..:**	5 mL
% Moisture.....:	17	**Analyst ID.....:**	402360	**Instrument ID..:**	S/T
		Method.........:	SW846 8082		

PARAMETER	RESULT	REPORTING LIMIT	UNITS	MDL
Aroclor 1016	ND	40	ug/kg	32
Aroclor 1221	ND	40	ug/kg	15
Aroclor 1232	ND	40	ug/kg	19
Aroclor 1242	ND	40	ug/kg	13
Aroclor 1248	ND	40	ug/kg	15
Aroclor 1254	ND	40	ug/kg	5.4
Aroclor 1260	**470**	**40**	**ug/kg**	**4.5**

SURROGATE	PERCENT RECOVERY	RECOVERY LIMITS
Tetrachloro-m-xylene	82	(31 - 127)
Decachlorobiphenyl	91	(23 - 141)

NOTE(S):

Results and reporting limits have been adjusted for dry weight.

Tetra Tech NUS, Inc

Client Sample ID: FC-SS-128

GC Semivolatiles

Lot-Sample #...:	C6A260253-017	**Work Order #...:**	HWCFM1AC	**Matrix.........:**	SOLID
Date Sampled...:	01/25/06	**Date Received..:**	01/26/06	**MS Run #.......:**	6027021
Prep Date......:	01/27/06	**Analysis Date..:**	01/28/06		
Prep Batch #...:	6027037	**Analysis Time..:**	19:59		
Dilution Factor:	1	**Initial Wgt/Vol:**	15 g	**Final Wgt/Vol..:**	5 mL
% Moisture.....:	35	**Analyst ID.....:**	402360	**Instrument ID..:**	S/T
		Method.........:	SW846 8082		

PARAMETER	RESULT	REPORTING LIMIT	UNITS	MDL
Aroclor 1016	ND	51	ug/kg	41
Aroclor 1221	ND	51	ug/kg	20
Aroclor 1232	ND	51	ug/kg	24
Aroclor 1242	ND	51	ug/kg	17
Aroclor 1248	ND	51	ug/kg	19
Aroclor 1254	ND	51	ug/kg	6.8
Aroclor 1260	ND	51	ug/kg	5.7

SURROGATE	PERCENT RECOVERY	RECOVERY LIMITS
Tetrachloro-m-xylene	71	(31 - 127)
Decachlorobiphenyl	78	(23 - 141)

NOTE(S):

Results and reporting limits have been adjusted for dry weight.

Tetra Tech NUS, Inc

Client Sample ID: DUP-012506-02

GC Semivolatiles

Lot-Sample #...:	C6A260253-018	**Work Order #...:**	HWCFQ1AC	**Matrix.........:**	SOLID
Date Sampled...:	01/25/06	**Date Received..:**	01/26/06	**MS Run #.......:**	6027021
Prep Date......:	01/27/06	**Analysis Date..:**	01/28/06		
Prep Batch #...:	6027037	**Analysis Time..:**	20:21		
Dilution Factor:	1	**Initial Wgt/Vol:**	15 g	**Final Wgt/Vol..:**	5 mL
% Moisture.....:	35	**Analyst ID.....:**	402360	**Instrument ID..:**	S/T
		Method.........:	SW846 8082		

PARAMETER	RESULT	REPORTING LIMIT	UNITS	MDL
Aroclor 1016	ND	51	ug/kg	41
Aroclor 1221	ND	51	ug/kg	20
Aroclor 1232	ND	51	ug/kg	24
Aroclor 1242	ND	51	ug/kg	17
Aroclor 1248	ND	51	ug/kg	19
Aroclor 1254	ND	51	ug/kg	6.8
Aroclor 1260	ND	51	ug/kg	5.7

SURROGATE	PERCENT RECOVERY	RECOVERY LIMITS
Tetrachloro-m-xylene	79	(31 - 127)
Decachlorobiphenyl	88	(23 - 141)

NOTE(S):

Results and reporting limits have been adjusted for dry weight.

Tetra Tech NUS, Inc

Client Sample ID: FC-SB-115-2535

GC Semivolatiles

Lot-Sample #...:	C6A260253-019	**Work Order #...:**	HWCFV1AC	**Matrix.........:**	SOLID
Date Sampled...:	01/24/06	**Date Received..:**	01/26/06	**MS Run #.......:**	6027021
Prep Date......:	01/27/06	**Analysis Date..:**	01/28/06		
Prep Batch #...:	6027037	**Analysis Time..:**	20:42		
Dilution Factor:	1	**Initial Wgt/Vol:**	15 g	**Final Wgt/Vol..:**	5 mL
% Moisture.....:	9.4	**Analyst ID.....:**	402360	**Instrument ID..:**	S/T
		Method.........:	SW846 8082		

PARAMETER	RESULT	REPORTING LIMIT	UNITS	MDL
Aroclor 1016	ND	36	ug/kg	29
Aroclor 1221	ND	36	ug/kg	14
Aroclor 1232	ND	36	ug/kg	17
Aroclor 1242	ND	36	ug/kg	12
Aroclor 1248	ND	36	ug/kg	13
Aroclor 1254	ND	36	ug/kg	4.9
Aroclor 1260	ND	36	ug/kg	4.1

SURROGATE	PERCENT RECOVERY	RECOVERY LIMITS
Tetrachloro-m-xylene	84	(31 - 127)
Decachlorobiphenyl	91	(23 - 141)

NOTE(S):

Results and reporting limits have been adjusted for dry weight.

Tetra Tech NUS, Inc

Client Sample ID: FC-SB-114-0102

GC Semivolatiles

Lot-Sample #...:	C6A260253-020	**Work Order #...:**	HWCF01AC	**Matrix.........:**	SOLID
Date Sampled...:	01/24/06	**Date Received..:**	01/26/06	**MS Run #.......:**	6027021
Prep Date......:	01/27/06	**Analysis Date..:**	01/28/06		
Prep Batch #...:	6027037	**Analysis Time..:**	21:04		
Dilution Factor:	1	**Initial Wgt/Vol:**	15 g	**Final Wgt/Vol..:**	5 mL
% Moisture.....:	10	**Analyst ID.....:**	402360	**Instrument ID..:**	S/T
		Method.........:	SW846 8082		

PARAMETER	RESULT	REPORTING LIMIT	UNITS	MDL
Aroclor 1016	ND	37	ug/kg	29
Aroclor 1221	ND	37	ug/kg	14
Aroclor 1232	ND	37	ug/kg	18
Aroclor 1242	ND	37	ug/kg	12
Aroclor 1248	ND	37	ug/kg	13
Aroclor 1254	ND	37	ug/kg	4.9
Aroclor 1260	ND	37	ug/kg	4.1

SURROGATE	PERCENT RECOVERY	RECOVERY LIMITS
Tetrachloro-m-xylene	84	(31 - 127)
Decachlorobiphenyl	90	(23 - 141)

NOTE(S):

Results and reporting limits have been adjusted for dry weight.

Tetra Tech NUS, Inc

Client Sample ID: DUP-012406-01

GC Semivolatiles

Lot-Sample #...:	C6A260253-021	**Work Order #...:**	HWCF11AC	**Matrix.........:**	SOLID
Date Sampled...:	01/24/06	**Date Received..:**	01/26/06	**MS Run #.......:**	6027010
Prep Date......:	01/26/06	**Analysis Date..:**	01/30/06		
Prep Batch #...:	6027020	**Analysis Time..:**	14:24		
Dilution Factor:	1	**Initial Wgt/Vol:**	15 g	**Final Wgt/Vol..:**	5 mL
% Moisture.....:	7.2	**Analyst ID.....:**	402360	**Instrument ID..:**	S/T
		Method.........:	SW846 8082		

PARAMETER	RESULT	REPORTING LIMIT	UNITS	MDL
Aroclor 1016	ND	36	ug/kg	29
Aroclor 1221	ND	36	ug/kg	14
Aroclor 1232	ND	36	ug/kg	17
Aroclor 1242	ND	36	ug/kg	12
Aroclor 1248	ND	36	ug/kg	13
Aroclor 1254	ND	36	ug/kg	4.8
Aroclor 1260	ND	36	ug/kg	4.0

SURROGATE	PERCENT RECOVERY	RECOVERY LIMITS
Tetrachloro-m-xylene	95	(31 - 127)
Decachlorobiphenyl	103	(23 - 141)

NOTE(S):

Results and reporting limits have been adjusted for dry weight.

Tetra Tech NUS, Inc

Client Sample ID: FC-SB-113-3545

GC Semivolatiles

Lot-Sample #...:	C6A260253-022	**Work Order #...:**	HWCF51AC	**Matrix.........:**	SOLID
Date Sampled...:	01/24/06	**Date Received..:**	01/26/06	**MS Run #.......:**	6027010
Prep Date......:	01/26/06	**Analysis Date..:**	01/30/06		
Prep Batch #...:	6027020	**Analysis Time..:**	14:46		
Dilution Factor:	1	**Initial Wgt/Vol:**	15 g	**Final Wgt/Vol..:**	5 mL
% Moisture.....:	8.7	**Analyst ID.....:**	402360	**Instrument ID..:**	S/T
		Method.........:	SW846 8082		

PARAMETER	RESULT	REPORTING LIMIT	UNITS	MDL
Aroclor 1016	ND	36	ug/kg	29
Aroclor 1221	ND	36	ug/kg	14
Aroclor 1232	ND	36	ug/kg	17
Aroclor 1242	ND	36	ug/kg	12
Aroclor 1248	ND	36	ug/kg	13
Aroclor 1254	ND	36	ug/kg	4.8
Aroclor 1260	**11 J**	**36**	**ug/kg**	**4.0**

SURROGATE	PERCENT RECOVERY	RECOVERY LIMITS
Tetrachloro-m-xylene	84	(31 - 127)
Decachlorobiphenyl	102	(23 - 141)

NOTE(S):

Results and reporting limits have been adjusted for dry weight.

J Estimated result. Result is less than RL.

Tetra Tech NUS, Inc

Client Sample ID: FB-012506

GC Semivolatiles

Lot-Sample #...:	C6A260253-023	**Work Order #...:**	HWCF61AA	**Matrix.........:**	WATER
Date Sampled...:	01/25/06	**Date Received..:**	01/26/06	**MS Run #.......:**	
Prep Date......:	01/27/06	**Analysis Date..:**	01/31/06		
Prep Batch #...:	6027443	**Analysis Time..:**	23:07		
Dilution Factor:	0.96	**Initial Wgt/Vol:**	1040 mL	**Final Wgt/Vol..:**	10 mL
Analyst ID.....:	402360	**Instrument ID..:**	S/T		
		Method.........:	SW846 8082		

PARAMETER	RESULT	REPORTING LIMIT	UNITS	MDL
Aroclor 1016	ND	0.96	ug/L	0.47
Aroclor 1221	ND	0.96	ug/L	0.43
Aroclor 1232	ND	0.96	ug/L	0.51
Aroclor 1242	ND	0.96	ug/L	0.24
Aroclor 1248	ND	0.96	ug/L	0.33
Aroclor 1254	ND	0.96	ug/L	0.34
Aroclor 1260	ND	0.96	ug/L	0.56

SURROGATE	PERCENT RECOVERY	RECOVERY LIMITS
Tetrachloro-m-xylene	80	(45 - 120)
Decachlorobiphenyl	97	(24 - 128)

ATTACHMENT D

DATA VALIDATION LETTERS

Tetra Tech NUS **INTERNAL CORRESPONDENCE**

TO:	**D. BRAYACK**	**DATE:**	**APRIL 5, 2006**
FROM:	**ERIN M. FAUST**	**COPIES:**	**DV FILE**

SUBJECT: **ORGANIC DATA VALIDATION – PCBs**
CTO 004 NWIRP CALVERTON, NY
SAMPLE DELIVERY GROUP (SDG) – C6A260253

SAMPLES: 22/Soils/

DUP-012406-01	DUP-012506-02	FC-SB-102-0607
FC-SB-102-3545	FC-SB-103-3545	FC-SB-104-0102
FC-SB-104-0607	FC-SB-106-0203	FC-SB-106-0607
FC-SB-108-0607	FC-SB-108-2535	FC-SB-113-3545
FC-SB-114-0102	FC-SB-115-2535	FC-SB-117-0203
FC-SB-119-3545	FC-SS-102	FC-SS-104
FC-SS-105	FC-SS-109	FC-SS-121
FC-SS-128		

1/Aqueous/

FB-012506

Overview

The sample set for CTO 004, NWIRP Calverton, SDG C6A260253, consists of twenty-two (22) soil environmental samples and one (1) aqueous field blank. Two (2) field duplicate pairs (DUP-012406-01 / FC-SB-114-0102 and DUP-012506-02 / FC-SS-128) are included within this SDG.

All samples were analyzed for polychlorinated biphenyls (PCBs) only. The samples were collected by Tetra Tech NUS on January 24 and 25, 2006 and analyzed by Severn Trent Laboratories – Pittsburgh under Naval Facilities Engineering Service Center (NFESC) Quality Assurance/Quality Control (QA/QC) criteria. PCB analyses were conducted using SW-846 method 8082.

These data were evaluated based on the following parameters:

- * Data Completeness
- * Holding Times
- * Initial and Continuing Calibration Results
- * Laboratory Method and Field Quality Control Blank Results
- * Field Duplicate Precision
- Detection Limits

* - All quality control criteria were met for this parameter.

Problems affecting data quality are discussed below; documentation supporting these findings is presented in Appendix D. Regional Worksheets are presented in Appendix C. Qualified Analytical results are presented in Appendix A. Results as reported by the laboratory are presented in Appendix B.

Detection Limits

The positive result, greater than the Method Detection Limit (MDL), but less than the Reporting Limit (RL), reported for Aroclor-1260 in sample FC-SB-113-3545 was qualified as estimated, "J", due to uncertainty near the detection limit.

Notes

The surrogate recoveries in sample FC-SS-102 were both 0%. No validation action was taken because the sample results were reported from a 400X dilution and the surrogates were diluted out. The surrogates were also diluted out in the 10X dilution of sample FC-SB-102-3545 and the 30X dilution of sample FC-SB-104-0607. Extraction efficiencies could not be evaluated for these samples.

Samples FC-SB-102-0607 and FC-SS-105 were reported from 2X dilutions. Sample FC-SS-104 was reported from a 3X dilution. Sample FC-SB-102-3545 was reported from a 10X dilution. Sample FC-SB-104-0607 was reported from a 30X dilution. Sample FC-SS-102 was reported from a 400X dilution.

Executive Summary

Laboratory Performance Issues: No laboratory-related issues affected data quality.

Other Factors Affecting Data Quality: The positive result, greater than the MDL, but less than the RL, reported for Aroclor-1260 in sample FC-SB-113-3545 was qualified due to uncertainty near the detection limit.

The data for these analyses were reviewed with reference to the "National Functional Guidelines for Organic Review", as amended for use within EPA Region II, January 1992 and the NFESC document entitled "Navy IRCDQM" (September 1999).

The text of this report has been formulated to address only those problem areas affecting data quality.

"I attest that the data referenced herein were validated according to the agreed upon validation criteria as specified in the NFESC Guidelines and the Quality Assurance Project Plan (QAPP)."

Erin M Faust

Tetra Tech NUS
Erin M. Faust
Environmental Scientist

Tetra Tech NUS
Joseph A. Samchuck
Quality Control Officer
Attachments:

1. Appendix A - Qualified Analytical Data
2. Appendix B - Results as reported by the Laboratory
3. Appendix C - Regional Worksheets
4. Appendix D - Support Documentation

APPENDIX A
QUALIFIED ANALYTICAL RESULTS

Data Validation Qualifier Codes:

A = Lab Blank Contamination
B = Field Blank Contamination
C = Calibration Noncompliance (e.g. % RSDs, %Ds, ICVs, CCVs, RRFs, etc.)
C01 = GC/MS Tuning Noncompliance
D = MS/MSD Recovery Noncompliance
E = LCS/LCSD Recovery Noncompliance
F = Lab Duplicate Imprecision
G = Field Duplicate Imprecision
H = Holding Time Exceedance
I = ICP Serial Dilution Noncompliance
J = GFAA PDS - GFAA MSA's $r < 0.995$ / ICP PDS Recovery Noncompliance
K = ICP Interference - includes ICS % R Noncompliance
L = Instrument Calibration Range Exceedance
M = Sample Preservation Noncompliance
N = Internal Standard Noncompliance
N01 = Internal Standard Recovery Noncompliance Dioxins
N02 = Recovery Standard Noncompliance Dioxins
N03 = Clean-up Standard Noncompliance Dioxins
O = Poor Instrument Performance (e.g. base-line drifting)
P = Uncertainty near detection limit (< 2 x IDL for inorganics and <CRQL for organics)
Q = Other problems (can encompass a number of issues; e.g. chromatography,interferences, etc.)
R = Surrogates Recovery Noncompliance
S = Pesticide/PCB Resolution
T = % Breakdown Noncompliance for DDT and Endrin
U = % Difference between columns/detectors >25% for positive results determined via GC/HPLC
V = Non-linear calibrations; correlation coefficient $r < 0.995$
W = EMPC result
X = Signal to noise response drop
Y = Percent solids <30%
Z = Uncertainty at 2 sigma deviation is greater than sample activity

PROJ_NO: 1610

SDG: C5A260253 MEDIA: WATER DATA FRACTION: PEST/PCB

nsample	FB-012506
samp_date	1/25/2006
lab_id	C6A260253023
qc_type	NM
units	UG/L
Pct_Solids	
DUP_OF:	

Parameter	Result	Val Qual	Qual Code
AROCLOR-1016	0.96	U	
AROCLOR-1221	0.96	U	
AROCLOR-1232	0.96	U	
AROCLOR-1242	0.96	U	
AROCLOR-1248	0.96	U	
AROCLOR-1254	0.96	U	
AROCLOR-1260	0.96	U	

PROJ_NO: 1610

SDG: C5A260253 MEDIA: SOIL DATA FRACTION: PEST/PCB

nsample	DUP-012406-01
samp_date	1/24/2006
lab_id	C6A260253021
qc_type	NM
units	UG/KG
Pct_Solids	92.8
DUP_OF:	FC-SB-114-0102

Parameter	Result	Val Qual	Qual Code
AROCLOR-1016	36	U	
AROCLOR-1221	36	U	
AROCLOR-1232	36	U	
AROCLOR-1242	36	U	
AROCLOR-1248	36	U	
AROCLOR-1254	36	U	
AROCLOR-1260	36	U	

nsample	DUP-012506-02
samp_date	1/25/2006
lab_id	C6A260253018
qc_type	NM
units	UG/KG
Pct_Solids	65.0
DUP_OF:	FC-SS-128

Parameter	Result	Val Qual	Qual Code
AROCLOR-1016	51	U	
AROCLOR-1221	51	U	
AROCLOR-1232	51	U	
AROCLOR-1242	51	U	
AROCLOR-1248	51	U	
AROCLOR-1254	51	U	
AROCLOR-1260	51	U	

nsample	FC-SB-102-0607
samp_date	1/25/2006
lab_id	C6A260253011
qc_type	NM
units	UG/KG
Pct_Solids	88.0
DUP_OF:	

Parameter	Result	Val Qual	Qual Code
AROCLOR-1016	75	U	
AROCLOR-1221	75	U	
AROCLOR-1232	75	U	
AROCLOR-1242	75	U	
AROCLOR-1248	75	U	
AROCLOR-1254	75	U	
AROCLOR-1260	2100		

PROJ_NO: 1610

SDG: C5A260253 MEDIA: SOIL DATA FRACTION: PEST/PCB

nsample	FC-SB-102-3545
samp_date	1/24/2006
lab_id	C6A260253001
qc_type	NM
units	UG/KG
Pct_Solids	90.8
DUP_OF:	

Parameter	Result	Val Qual	Qual Code
AROCLOR-1016	360	U	
AROCLOR-1221	360	U	
AROCLOR-1232	360	U	
AROCLOR-1242	360	U	
AROCLOR-1248	360	U	
AROCLOR-1254	360	U	
AROCLOR-1260	5400		

nsample	FC-SB-103-3545
samp_date	1/24/2006
lab_id	C6A260253008
qc_type	NM
units	UG/KG
Pct_Solids	90.2
DUP_OF:	

Parameter	Result	Val Qual	Qual Code
AROCLOR-1016	37	U	
AROCLOR-1221	37	U	
AROCLOR-1232	37	U	
AROCLOR-1242	37	U	
AROCLOR-1248	37	U	
AROCLOR-1254	37	U	
AROCLOR-1260	410		

nsample	FC-SB-104-0102
samp_date	1/24/2006
lab_id	C6A260253002
qc_type	NM
units	UG/KG
Pct_Solids	90.0
DUP_OF:	

Parameter	Result	Val Qual	Qual Code
AROCLOR-1016	37	U	
AROCLOR-1221	37	U	
AROCLOR-1232	37	U	
AROCLOR-1242	37	U	
AROCLOR-1248	37	U	
AROCLOR-1254	37	U	
AROCLOR-1260	94		

PROJ_NO: 1610

SDG: C5A260253 MEDIA: SOIL DATA FRACTION: PEST/PCB

nsample	FC-SB-104-0607
samp_date	1/25/2006
lab_id	C6A260253012
qc_type	NM
units	UG/KG
Pct_Solids	87.0
DUP_OF:	

Parameter	Result	Val Qual	Qual Code
AROCLOR-1016	1100	U	
AROCLOR-1221	1100	U	
AROCLOR-1232	1100	U	
AROCLOR-1242	1100	U	
AROCLOR-1248	1100	U	
AROCLOR-1254	1100	U	
AROCLOR-1260	17000		

nsample	FC-SB-106-0203
samp_date	1/24/2006
lab_id	C6A260253003
qc_type	NM
units	UG/KG
Pct_Solids	92.6
DUP_OF:	

Parameter	Result	Val Qual	Qual Code
AROCLOR-1016	36	U	
AROCLOR-1221	36	U	
AROCLOR-1232	36	U	
AROCLOR-1242	36	U	
AROCLOR-1248	36	U	
AROCLOR-1254	36	U	
AROCLOR-1260	36	U	

nsample	FC-SB-106-0607
samp_date	1/25/2006
lab_id	C6A260253013
qc_type	NM
units	UG/KG
Pct_Solids	89.0
DUP_OF:	

Parameter	Result	Val Qual	Qual Code
AROCLOR-1016	37	U	
AROCLOR-1221	37	U	
AROCLOR-1232	37	U	
AROCLOR-1242	37	U	
AROCLOR-1248	37	U	
AROCLOR-1254	37	U	
AROCLOR-1260	37	U	

PROJ_NO: 1610

SDG: C5A260253 MEDIA: SOIL DATA FRACTION: PEST/PCB

nsample	FC-SB-108-0607
samp_date	1/25/2006
lab_id	C6A260253014
qc_type	NM
units	UG/KG
Pct_Solids	86.0
DUP_OF:	

Parameter	Result	Val Qual	Qual Code
AROCLOR-1016	38	U	
AROCLOR-1221	38	U	
AROCLOR-1232	38	U	
AROCLOR-1242	38	U	
AROCLOR-1248	38	U	
AROCLOR-1254	38	U	
AROCLOR-1260	38	U	

nsample	FC-SB-108-2535
samp_date	1/24/2006
lab_id	C6A260253004
qc_type	NM
units	UG/KG
Pct_Solids	95.1
DUP_OF:	

Parameter	Result	Val Qual	Qual Code
AROCLOR-1016	35	U	
AROCLOR-1221	35	U	
AROCLOR-1232	35	U	
AROCLOR-1242	35	U	
AROCLOR-1248	35	U	
AROCLOR-1254	35	U	
AROCLOR-1260	35	U	

nsample	FC-SB-113-3545
samp_date	1/24/2006
lab_id	C6A260253022
qc_type	NM
units	UG/KG
Pct_Solids	91.3
DUP_OF:	

Parameter	Result	Val Qual	Qual Code
AROCLOR-1016	36	U	
AROCLOR-1221	36	U	
AROCLOR-1232	36	U	
AROCLOR-1242	36	U	
AROCLOR-1248	36	U	
AROCLOR-1254	36	U	
AROCLOR-1260	11	J	P

PROJ_NO: 1610

SDG: C5A260253 MEDIA: SOIL DATA FRACTION: PEST/PCB

nsample	FC-SB-114-0102
samp_date	1/24/2006
lab_id	C6A260253020
qc_type	NM
units	UG/KG
Pct_Solids	90.0
DUP_OF:	

Parameter	Result	Val Qual	Qual Code
AROCLOR-1016	37	U	
AROCLOR-1221	37	U	
AROCLOR-1232	37	U	
AROCLOR-1242	37	U	
AROCLOR-1248	37	U	
AROCLOR-1254	37	U	
AROCLOR-1260	37	U	

nsample	FC-SB-115-2535
samp_date	1/24/2006
lab_id	C6A260253019
qc_type	NM
units	UG/KG
Pct_Solids	90.6
DUP_OF:	

Parameter	Result	Val Qual	Qual Code
AROCLOR-1016	36	U	
AROCLOR-1221	36	U	
AROCLOR-1232	36	U	
AROCLOR-1242	36	U	
AROCLOR-1248	36	U	
AROCLOR-1254	36	U	
AROCLOR-1260	36	U	

nsample	FC-SB-117-0203
samp_date	1/25/2006
lab_id	C6A260253009
qc_type	NM
units	UG/KG
Pct_Solids	92.5
DUP_OF:	

Parameter	Result	Val Qual	Qual Code
AROCLOR-1016	36	U	
AROCLOR-1221	36	U	
AROCLOR-1232	36	U	
AROCLOR-1242	36	U	
AROCLOR-1248	36	U	
AROCLOR-1254	36	U	
AROCLOR-1260	36	U	

PROJ_NO: 1610

SDG: C5A260253 MEDIA: SOIL DATA FRACTION: PEST/PCB

nsample	FC-SB-119-3545
samp_date	1/25/2006
lab_id	C6A260253010
qc_type	NM
units	UG/KG
Pct_Solids	91.0
DUP_OF:	

Parameter	Result	Val Qual	Qual Code
AROCLOR-1016	36	U	
AROCLOR-1221	36	U	
AROCLOR-1232	36	U	
AROCLOR-1242	36	U	
AROCLOR-1248	36	U	
AROCLOR-1254	36	U	
AROCLOR-1260	36	U	

nsample	FC-SS-102
samp_date	1/24/2006
lab_id	C6A260253005
qc_type	NM
units	UG/KG
Pct_Solids	86.0
DUP_OF:	

Parameter	Result	Val Qual	Qual Code
AROCLOR-1016	15000	U	
AROCLOR-1221	15000	U	
AROCLOR-1232	15000	U	
AROCLOR-1242	15000	U	
AROCLOR-1248	15000	U	
AROCLOR-1254	15000	U	
AROCLOR-1260	330000		

nsample	FC-SS-104
samp_date	1/24/2006
lab_id	C6A260253006
qc_type	NM
units	UG/KG
Pct_Solids	87.0
DUP_OF:	

Parameter	Result	Val Qual	Qual Code
AROCLOR-1016	110	U	
AROCLOR-1221	110	U	
AROCLOR-1232	110	U	
AROCLOR-1242	110	U	
AROCLOR-1248	110	U	
AROCLOR-1254	110	U	
AROCLOR-1260	3100		

PROJ_NO: 1610

SDG: C5A260253 MEDIA: SOIL DATA FRACTION: PEST/PCB

nsample	FC-SS-105
samp_date	1/24/2006
lab_id	C6A260253007
qc_type	NM
units	UG/KG
Pct_Solids	85.0
DUP_OF:	

Parameter	Result	Val Qual	Qual Code
AROCLOR-1016	78	U	
AROCLOR-1221	78	U	
AROCLOR-1232	78	U	
AROCLOR-1242	78	U	
AROCLOR-1248	78	U	
AROCLOR-1254	78	U	
AROCLOR-1260	2100		

nsample	FC-SS-109
samp_date	1/25/2006
lab_id	C6A260253015
qc_type	NM
units	UG/KG
Pct_Solids	77.0
DUP_OF:	

Parameter	Result	Val Qual	Qual Code
AROCLOR-1016	43	U	
AROCLOR-1221	43	U	
AROCLOR-1232	43	U	
AROCLOR-1242	43	U	
AROCLOR-1248	43	U	
AROCLOR-1254	43	U	
AROCLOR-1260	91		

nsample	FC-SS-121
samp_date	1/25/2006
lab_id	C6A260253016
qc_type	NM
units	UG/KG
Pct_Solids	83.0
DUP_OF:	

Parameter	Result	Val Qual	Qual Code
AROCLOR-1016	40	U	
AROCLOR-1221	40	U	
AROCLOR-1232	40	U	
AROCLOR-1242	40	U	
AROCLOR-1248	40	U	
AROCLOR-1254	40	U	
AROCLOR-1260	470		

nsample	FC-SS-128
samp_date	1/25/2006
lab_id	C6A260253017
qc_type	NM
units	UG/KG
Pct_Solids	65.0
DUP_OF:	

Parameter	Result	Val Qual	Qual Code
AROCLOR-1016	51	U	
AROCLOR-1221	51	U	
AROCLOR-1232	51	U	
AROCLOR-1242	51	U	
AROCLOR-1248	51	U	
AROCLOR-1254	51	U	
AROCLOR-1260	51	U	

ATTACHMENT E

PCB TEST KIT METHODOLOGY

STRATEGIC DIAGNOSTICS INC.

Ensys™ PCB Soil Test Kit, EPA Method 4020
7020301

Intended Use

The Ensys PCB Soil Test Kit is a qualitative or semi-quantitative enzyme immunoassay (EIA) for the analysis of polychlorinated biphenyls (PCB) at user specified detection levels in soil. The method correctly identifies 95% of samples that are PCB-free and those containing 1 ppm or greater of PCBs.

Background

PCBs are a family of compounds with 209 individual forms (or congeners) containing from 1-10 chlorine atoms on the biphenyl structure. PCBs were originally sold in the United States under the trade name Aroclor. Each Aroclor is composed of many congeners. Many congeners may appear in more than one Aroclor. Aroclors are differentiated on the basis of average chlorine content (percent chlorine by weight). For Aroclor nomenclature, the last two digits of the four-digit label indicate this percentage. For example, Aroclor 1248 is approximately 48% chlorine by weight.

Test Principles

The Ensys PCB Soil Test Kit is based on the use of antibodies that bind either PCB or PCB-Enzyme Conjugate. These antibodies are immobilized on the walls of the test tubes. When PCB is present in the sample, it competes with the PCB-Enzyme Conjugate for a limited number of PCB binding sites on the immobilized antibodies.

- A sample containing PCB is added to a test tube containing PCB-Enzyme Conjugate. The PCB-Enzyme Conjugate competes with the PCB for the antibody binding sites.
- After incubation, the unbound molecules are washed away.
- Chromogenic Substrate is then added to the test tube. In the presence of bound PCB-Enzyme Conjugate, the clear Substrate is converted to a blue color. One enzyme molecule can convert many Substrate molecules.

Since every test tube has the same number of antibody binding sites and receives the same number of PCB-Enzyme Conjugate molecules, a sample that contains a low concentration of PCB allows the antibody to bind many PCB-Enzyme Conjugate molecules. Therefore, a low concentration of PCB produces a dark blue solution. Conversely, a high concentration of PCB allows fewer PCB-Enzyme Conjugate molecules to be bound by the antibodies, resulting in a lighter blue solution.

NOTE: Color development is inversely proportional to the PCB concentration.

Darker color = lower concentration
Lighter color = higher concentration

The determination of the PCB level in an unknown sample is interpreted relative to the kit standard using visual comparison or by reading with a spectrophotometer. The standard is at a fixed concentration; therefore, the kit detection levels are determined by the dilution of the sample being analyzed. Dilution ampules are provided in the test kit based on the detection level(s) and aroclor specified at the time of ordering.

Performance Characteristics

The Ensys PCB Soil Test Kit is specific for PCB Aroclor congeners. Different Aroclors are detected with varying sensitivity, as per the table below, which indicates the minimum and maximum detection levels that can be accurately achieved with this test kit for various aroclors.

Aroclor	Minimum Detection Level	Maximum Detection Level
1260	0.5 ppm	500 ppm
1254	0.5 ppm	500 ppm
1248	1.0 ppm	500 ppm

1242	2.0 ppm	500 ppm
1232	4.0 ppm	500 ppm
1016	4.0 ppm	500 ppm

- Kit standard is Aroclor 1248

Precautions

- Treat PCB, solutions that contain PCB, and potentially contaminated soil samples as hazardous materials.
- Use gloves, proper protective clothing, and methods to contain and handle hazardous material where appropriate.
- Store all test kit components at ambient temperature (18°C to 27°C or 64°F to 81°F). Do not freeze test kit components.
- This test kit should be operated between 40°F (4°C) and 90°F (32°C)..
- Do not use test kit components after the expiration date.
- Do not use reagents or test tubes from one test kit with reagents or test tubes from a different test kit.
- Do not mix reagents from kits of different lot numbers.
- Use approved methodologies to confirm any positive results.
- Soils obtained from areas adjacent to standing water, surface soils collected during or immediately after rain or snow, or any soils with relatively high amounts of water ($\geq$ 30% by weight) should be dried before testing. Contact technical service for recommended methods.
- Distribution of PCBs in soils may be highly variable. Adequate sample number and distribution are the responsibility of the analyst.
- Portable spectrophotometer battery must be fully charged prior to use. It will not run directly off of AC current.
- Do not expose substrate to direct sunlight.
- Do not dilute or adulterate test reagents or use samples not called for in the test procedure; this may give inaccurate results.
- Tightly recap the PCB calibrator vials to prevent evaporative loss.
- Soils containing high levels of petroleum fuels or transformer oil may affect results. If the addition of sample to the buffer tube results in a cloudy suspension it indicates the presence of petroleum fuels or transformer oil in the sample and results may be invalid.

Materials Provided

- 48 Antibody coated test tubes (12 x75) in a foil pouch
- 2 ampules of PCB Standard (in methanol)
- 48 Glass buffer tubes (10 X 75)
- 48 PCB-Enzyme Conjugate vials w/ gray stoppers
- 15 mL bottle of Substrate A
- 15 mL bottle of Substrate B
- 15 mL bottle of Stop Solution
- 60 mL bottle of Buffer
- 480 mL bottles of Wash Solution (2)
- 24 Pink (50-250 µL) Gilson Microman® positive displacement pipette tips
- User's Guide
- Bulb pipettes (3)
- Amber vials with screw caps (3)
- 12 Small ampule crackers
- 5.0 mL Combitips for Repeater pipettor (3)
- 12.5 mL Combitip for Repeater pipettor

Materials Required and Ordered Separately

See "Ordering Information" for the appropriate catalogue numbers.

SDI Sample Extraction Kit

Use this kit for the extraction of PCB from soil samples. This kit contains enough devices to process 12 samples:

- 12 Extraction jars with screw caps (each bottle contains 3 stainless steel mixing beads)
- 12 Filter modules (tops and bottoms)
- 12 Ampule crackers
- 12 Wooden spatulas
- 12 Weigh Canoes
- 12 Disposable Transfer Pipettes
- 12 Ampules containing 20 mL each of 100% Methanol
- Dilution series with ampules containing required volume of methanol to achieve user defined detection levels

Ensys/Envirogard Field Soil Lab (Accessory Kit)

Accessory equipment may be rented or purchased from Strategic Diagnostics. See "Ordering Information" for the appropriate catalogue numbers.

The accessory kit contains the following items:

- Gilson M-25 Microman Positive Displacement Pipettor
- Eppendorf™ Repeater® Pipettor
- Electronic timer
- Polystyrene test tubes, 12 x 75 mm (for blanking spectrophotometer)
- Portable balance capable of weighing 10 g
- Wash bottle
- 5.0 mL Combitips® for the Repeater pipettor -for 0.1 mL to 0.5 mL dispensing volumes (3)
- 12.5 mL Combitips® for the Repeater pipettor -for 0.25 mL to 1.250 mL dispensing volumes (6)
- 50.0 mL Combitip® for the Repeater pipettor (with adapter)-for 1.0 mL to 5.0 mL dispensing volumes (1)
- Foam workstation
- Differential photometer - allows you to measure results in the form of optical density values. These values can be used for objective record keeping and quality assurance.

NOTE: Order replacement Combitips® and positive displacement tips separately. See the "Ordering Information" section.

Materials Required but Not Provided

- Protective clothing (e.g., latex gloves)
- Absorbent paper for blotting test tubes
- Liquid and solid waste containers
- Marking pen

Suggestions for Pipettor Use

- Practice using both pipettors (positive displacement and Repeater pipettor) with water and extra tips before you analyze your samples.
- Use a new tip each time you use the Repeater pipettor to pipette a different reagent to avoid reagent cross-contamination. Tips can be rinsed thoroughly and reused. By using the same tip to dispense the same reagent each time you can avoid cross contamination.
- Draw the desired reagent volume into the Repeater pipettor and dispense one portion of the reagent back into the container to properly engage the ratchet mechanism. If you do not do this, the first volume delivered may be inaccurate.
- To add reagents using the Repeater pipettor, pipette down the side of the test tube just below the rim.
- When adding samples and standard using the positive displacement pipettor, always pipette below the liquid level. Pipet liquid up and down in tip to ensure complete volume transfer.
- The carryover volume of the positive displacement tips is minimal, but may affect results if you are going from a high to low PCB concentration. Use a new pipettor tip each time you pipette a new unknown.

Assay Procedure

Collect/Store the Sample

The following steps explain how to properly collect and store your samples.

1. Collect soil in appropriately sized and labeled containers.
2. Take care to remove excess twigs, organic matter, and rocks or pebbles from the soil sample to be tested.

3. Soils obtained from areas adjacent to standing water, surface soils collected during or immediately after rain or snow, or any soils with relatively high amounts of water (≥ 30% by weight) should be dried before testing. Contact Technical Services for recommended methods.

4. Store soil samples at 4°C (39°F).

Workstation Set Up

1. Open one of the ampules labeled "PCB Standard" by slipping the ampule cracker over the top and breaking the tip at the scored neck. Transfer the solution in the ampule to one of the empty amber vials using a bulb pipet and cap the vial. The vial should then be labeled with the current date.

NOTE: The standard is good for two weeks after being transferred from the ampule. After two weeks, a new standard ampule should be opened.

2. Label three 5.0 mL Combitips found in your PCB Soil test kit "A", "B" and "Stop". Label the larger 12.5 mL Combitip "Buffer".

3. Set up the workstation as indicated on Page 7 of this User's Guide.

4. Label the glass buffer tubes and antibody coated tubes as follows (This is an example of how tubes might be labeled for 1 and 10 ppm detection levels. (Do not attempt to run more than 12 tubes per assay, two of which must be standards.):

Tube Label	Tube Contents
Std1	Standard (replicate 1)
Std2	Standard (replicate 2)
#1 - 1 ppm	Sample 1 (1 ppm detection)
#1 - 10 ppm	Sample 1 (10 ppm detection)
#2 - 1ppm	Sample 2 (1 ppm detection)

***Label at top of tubes to avoid interference with reading of tubes in photometer**

Extract the Soil/Dilute the Sample

1. Please follow the instructions from the SDI Sample Extraction Kit to prepare the soil extract before the assay. **20 mL** of **100 % Methanol** will be used to extract PCB residue from a **10 g** soil sample.

2. Position the Repeater pipettor at Setting **4** and use the **12.5 mL** "Buffer" tip to add **1 mL** of Buffer to all glass buffer tubes in Row 2.

3. Open a series of dilution ampules in Row 1 for each sample to be tested by slipping an ampule cracker over the top and breaking at the scored neck. (When testing at 1 and 10 ppm, for example, a 1 and 10 ppm dilution ampule should be opened for each sample.)

NOTE: If your kit includes intermediate dilution ampules to reach your detection level they should be opened for each sample as well.

4. Attach a clean pink pipette tip to the positive displacement pipet and adjust the dial to **"060"** to pipet **60 µL**. Use the pipettor to withdraw 60 uL of filtered sample extract from the filter unit to the dilution ampule with the lowest ppm level. Gently shake ampule from side to side for 5 seconds to mix thoroughly.

5. Withdraw **60 uL** of diluted sample from the first dilution ampule using the positive displacement pipet and transfer to the next highest dilution ampule provided in your kit. Gently shake the ampule from side to side for 5 seconds to mix thoroughly. Continue this procedure for all ampules provided in the dilution series, transferring from the lowest to highest ppm value.

EVERY AMPULE PROVIDED IN THE DILUTION SERIES MUST BE USED IN ORDER TO ACHIEVE YOUR TEST LEVELS!!

6. After all dilutions have been made, use the same pipet tip used for dilution to transfer 60 uL from each dilution ampule to the corresponding glass buffer tube in Row 2.

NOTE: Always begin transfers from ampules to buffer tubes starting with the highest ppm dilution ampule and working to the to the lowest ppm ampule. Wipe the tip of the pipet after dispensing to minimize cross contamination. Do not transfer from dilution ampules which are not at your desired testing levels to glass buffer tubes as this uses reagents and reduces the number of samples obtained per kit.

7. Repeat Steps 4-6 for each sample to be tested, using a clean pipette tip for each new sample.

8. Assemble a new pipette tip on the positive displacement pipette and transfer 60 uL from the standard vial into each of two corresponding glass buffer tubes in Row 2.

CAUTION: Replace the cap(s) on the standard vials immediately after use to minimize evaporation.

9. Gently shake all of the glass buffer tubes for 5 seconds to mix.

Perform the Test

1. Fit all antibody coated tubes in Row 3 firmly on top of all corresponding glass buffer tubes in Row 2. Set a timer for 10 minutes, start the timer and immediately invert all connected tube pairs, working left to right in the workstation. This will transfer buffer to the antibody coated tube. Make sure the plastic antibody coated tube is on the bottom.

2. Again working left to right in the workstation, invert the connected tube pairs three more times, making sure the antibody coated tubes are on the bottom and seated in Row 2 when complete.

3. Disconnect and discard the glass buffer tubes. Do not worry about drops of liquid adhering to the lips of the tubes.

4. During incubation, place conjugate tubes in Row 3 corresponding to each antibody tube in Row 2. Label the conjugate tubes with appropriate sample identification. Remove the grey stoppers and discard.

5. After the 10 minute incubation is over, reset the timer for 5 minutes.

6. Start the timer and immediately dissolve the conjugate pellets by pouring the contents of the antibody coated tubes in Row 2 into their corresponding conjugate tubes in Row 3. Be careful not to spill contents of tubes. Connect the tube pair and transfer the liquid back into the antibody coated tube. Return the connected tube pair to the workstation row making sure the larger antibody coated tube is on the bottom. **It is important that this step is completed within one minute for all tubes.**

7. Invert all connected tube pairs three more times making sure that the pair is returned to the workstation with the larger antibody coated tube on the bottom. Disconnect and discard the smaller conjugate tubes (again, it is not important to worry about the loss of liquid adhering to the lip of the tubes.)

8. After the 5 minute incubation, vigorously shake out the test tube contents into a sink or suitable container. Wash the tubes by vigorously filling and emptying a total of four times with the Wash Solution provided in the test kit. After the last wash, tap the tubes upside down on paper towels to remove excess liquid. (Residual foam will not interfere with results.)

9. Position the Repeater pipettor at Setting **2** and use the **5.0 mL** Combitip labeled "A" to add **200 µL** of Substrate A to all test tubes.

10. Set the timer for exactly 2 ½ minutes but do not start it.

11. Assemble the **5.0 mL** "B" tip on the Repeater pipettor at Setting **2** and fill the tip with Substrate B.

12. Start the timer and use the Repeater pipettor to add **200 uL** of Substrate B to all test tubes. Shake all tubes for 5 seconds. Solution will turn blue in some or all of the tubes.

13. After the 2 ½ minute incubation, position the Repeater pipettor at Setting **2** and use a **5.0 mL** Combitip to add **200 µL** of Stop Solution to all test tubes. This will turn the color from blue to yellow.

WARNING: **Stop solution contains sulfuric acid. Handle carefully.**

Results Interpretation

You can either interpret the results visually within 5 minutes after adding the Substrate to each test tube, or you can perform a more precise analysis with a photometer after you add the Stop Solution.

Visual Interpretation

After you add the Substrate, wait 5 minutes then mix the test tubes by shaking them for a few seconds. Compare the sample test tube to the lighter standard tube against a white background.

- If a sample test tube contains *more* color than the standard test tube, the sample contains PCB at a concentration *lower* than the level being tested.

- If a sample test tube contains *less* color than the standard test tube, the sample may contain PCB at a concentration *greater* than the level being tested.

Photometric Interpretation

NOTE: After you add Stop Solution to the test tubes, results should be read within 30 minutes.

1. Dry the outside of all antibody coated tubes prior to photmetric analysis.

2. Place both standard tubes in the differential photometer.

3. Switch the tubes until the photometer reading is negative or zero. Record the reading.

NOTE: The standard is run in duplicate to provide internal test system quality control. With both standards inserted in the photometer, a valid test is indicated when the magnitude of the displayed number (irrespective of the sign + or -) is less than 0.30. If the number obtained is greater than 0.30 the results are outside QC limits and the test should be repeated to ensure valid conclusions.

4. Remove and discard the tube in the right well of the photometer. The tube in the left well is the conservative standard to which your sample tubes will be compared.

5. Place the antibody coated tubes corresponding to each sample into the right well of the photometer one at a time and record the readings.

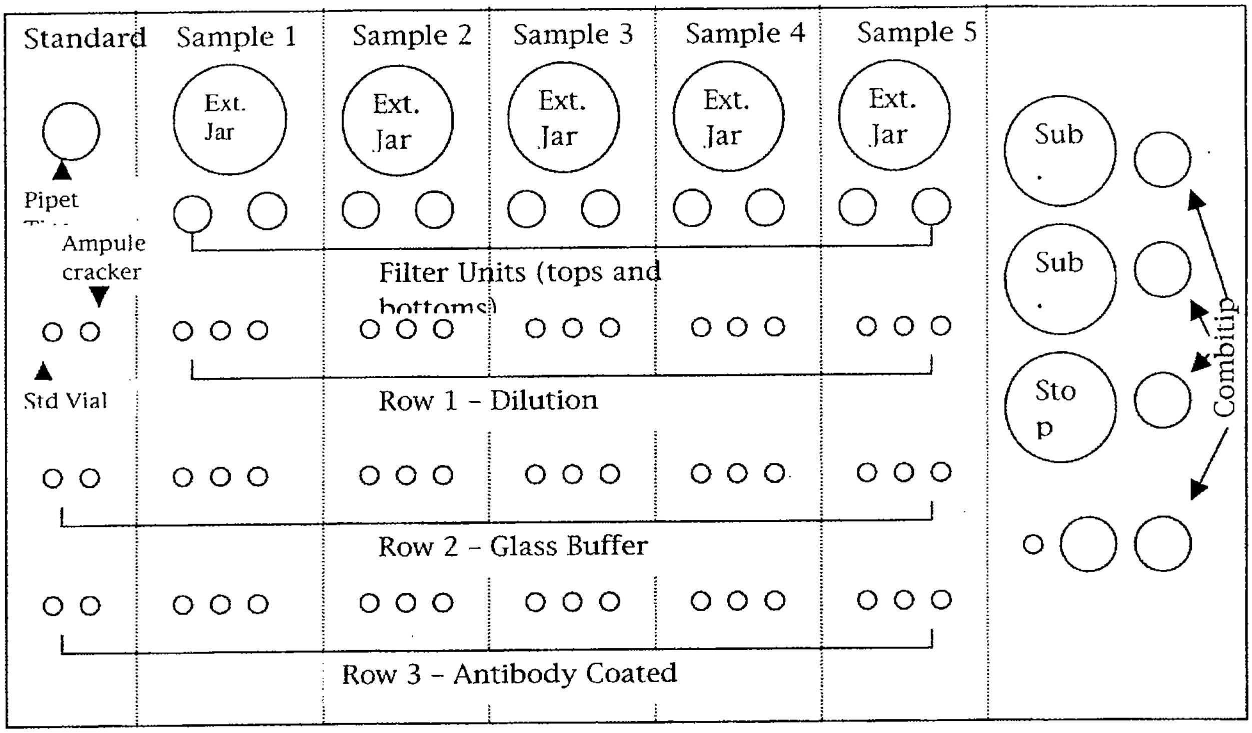
   - If the photometer reading is negative or zero, PCBs are present at a level greater than or equal to the testing level for that sample.
   - If the photometer reading is positive, the concentration of PCBs is less than the testing level for that sample.

Limitations of the Procedure

The Ensys PCB Soil Test Kit is a screening test **only.**

Soil sampling error may significantly affect testing reliability. The distribution of PCBs in soils can be extremely heterogeneous. Adequate sample number and distribution are the responsibility of the analyst.

Ensys PCB in Soil Workstation Set Up



1. Remove foam workstation from Ensys/Envirogard Field Accessory Kit.
2. Open the SDI Sample Extraction Kit and remove an extraction jar for each sample to be tested. Place in the foam workstation as indicated on the diagram above. The extraction kit also contains bulb pipets which may be placed in the small hole to the left of each extraction jar (not shown).
3. Place a filter unit (top and bottom) from the extraction kit under each extraction jar in the workstation corresponding to each sample.
4. Remove the box of dilution ampules contained in the SDI Sample Extraction kit and place a complete dilution series from the box for each sample to be tested under the filter units corresponding to each sample in the workstation.

NOTE: A dilution series includes ampules for each level ordered as well as any intermediate levels needed to obtain your desired detection level. EVERY AMPULE IN THE SERIES MUST BE USED IN ORDER TO REACH YOUR DETECTION LEVELS.

5. Place the standard prepared in Step 1 of "Workstation Set Up" in the Ensys PCB Soil Test Kit User's Guide into the hole on the far left of Row 1 in the workstation as indicated on the diagram. Place one of the small ampule crackers provided in the Ensys PCB Soil Test Kit into the hole next to the standard.
6. Into Row 2 place glass buffer tubes (which are the plain glass test tubes in the small box in your test kit) for the desired testing levels for every sample to be tested. (A glass buffer tube should not be added for intermediate levels included in the dilution series.) In the two left holes on Row 2 place two glass buffer tubes for your standard.
7. Antibody coated tubes, which are in the foil pouch in your test kit, should be placed in Row 3 corresponding to each glass buffer tube in Row 2. Keep foil pouch sealed when not in use.
8. Place the bottles of Substrate A, B and Stop into the appropriate workstation holes indicated on the diagram along with their corresponding labeled 5.0 mL Combitips. Place the 12.5 mL Combitip labeled "Buffer" into the hole under those for the 5.0 mL tips.
9. One pink positive displacement pipet tip should be placed in the hole in the upper left corner of the workstation for every sample being tested. An additional tip should be placed in this hole for the standard. These tips will be used perform dilutions and transfer sample to the buffer tubes.

Ordering Information

Description	Catalogue Number
Ensys PCB Soil Test Kit	7020301
SDI Soil Sample Extraction Kit (with methanol in ampules or bulk)	7020301EA / 7020301EB
Ensys/Envirogard Field Soil Lab (Accessory Kit)**	6050400
Differential Photometer (110V)	6000001
Differential Photometer (220V)	6000002
5 mL Combitip for Repeating Pipette (1 each)	6005200
12.5 mL Combitip for Repeating Pipette (1 each)	A00009
50 mL Combitip for Repeating Pipette (1 each)	6005600
Gilson Microman Positive Displacement Pipette Tips- yellow (200/bag)	6030500
Gilson Microman Positive Displacement Pipette Tips - pink (200/bag)	6030600
Ensys/Envirogard Field Soil Lab (Accessory Kit) Rental	6997020
**** To obtain part numbers and pricing for individual items in the Field Soil Lab contact SDI at the number below.**	

Ordering/Technical Assistance

Should you have any questions regarding this procedure prior to analysis contact Technical Service to avoid costly mistakes.

To Place an Order or Receive Technical Assistance, please call Strategic Diagnostics Inc. at:

Call toll-free: **800-544-8881**
Or 302-456-6789 Phone
302-456-6782 Fax
Web site: www.sdix.com
E-mail: techservice@sdix.com

General Limited Warranty

SDI's products are manufactured under strict quality control guidelines and are warranted to be free from defects in materials and workmanship. New instruments and related non-expendable items are warranted for one year from date of shipment against defective materials or workmanship under normal use and service.

Warranty obligation is limited to repair or replacement of the defective product or to refund of the purchase price, at the discretion of SDI. Other warranties, express or implied, are disclaimed. SDI's liability under any warranty claim shall not exceed the refund of the purchase price paid by the customer. Under no circumstances shall SDI be liable for special, indirect or consequential damages.

Safety

To receive an MSDS for this product, visit our web site at www.sdix.com.

Operation of the Repeater Pipet

To Set or Adjust Volume

To determine the pipetting volume, the dial setting (1-5) is multiplied by the minimum pipetting volume of the tip (indicated on the side of the Combitip, e.g. 1≃100 uL.)

To Assemble Pipet Tip

Slide filling lever down until it stops. Then raise the locking clamp and insert the tip until it clicks into position. Be sure the tip plunger is fully inserted into the barrel before lowering the locking clamp to affix the tip in place.

To Fill Tip

With tip mounted in position on pipet, immerse end of tip into solution. Slide filling lever upward slowly. Combitip will fill with liquid.

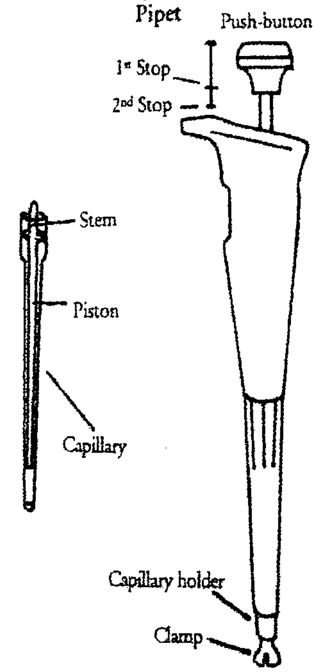
To Dispense Sample

Check the volume selection dial to ensure pipetting volume. Place tip inside test tube so that tip touches the inner wall of tube. Completely depress the pipetting lever to deliver sample. NOTE: Dispense one portion of reagent back into the container to engage the ratchet mechanism and ensure accuracy.

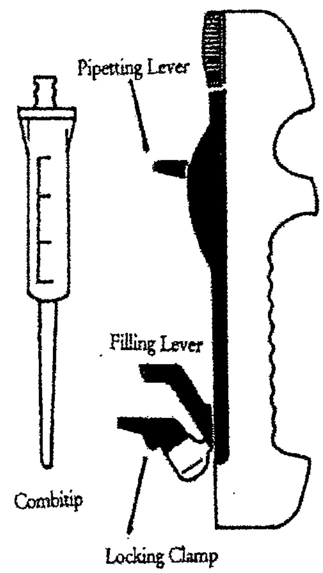
To Eject Tip

Empty tip of any remaining solution into appropriate container by pushing filling lever down. Raise locking clamp upward, and remove the Combitip.

Positive Displacement Pipet



Repeater Pipet



Operation of the Positive Displacement Pipet

To Set or Adjust Volume

Turn lower part of push-button to adjust volume up or down. See kit instructions for appropriate setting.

To Assemble Pipet Tip

Press push button to 2nd stop to open clamp (see diagram, this is as far as push button will go down.) Select piston and slide stem fully into clamp. Slide mounted piston into capillary. Gently push capillary until it snaps onto capillary holder.

To Withdraw Sample

With tip mounted in position on pipet, press push-button to 1st stop and hold it. (If you push beyond the 1st stop tip will eject.) Place tip at bottom of liquid sample and slowly release push-button to withdraw measured sample. Ensure that no air bubbles exist in the pipette tip. If bubbles exist, dispense sample and re-withdraw.

To Dispense Sample

Wipe any liquid from outside of capillary taking care not to touch orifice. Place tip into dispensing vessel (immersing end of the tip if vessel contains liquid) and slowly press push-button to 1st stop. Pipet liquid up and down in tip to ensure complete transfer. Hold push-button at 1st stop when removing tip from vessel.

To Eject Tip

Press push-button to second stop. Tip (capillary and piston) is ejected.

NOTE: **When using yellow tips on the positive displacement pipet, pipetting volumes range from 5-25 uL. (i.e. Pipet set on 2-5-0 will pipet 25 uL.)**
When using pink tips on the positive displacement pipet, pipetting volumes range from 50-250 uL. (i.e. Pipet set on 2-5-0 will pipet 250 uL.)

ATTACHMENT F

PCB TEST KIT RESULTS

Data for SDI PCB EnSys® 12T Soil Test

Operator: Megan Ritchie Date: 1/25/06 Location: Calverton Site 6A

Sample ID	ΔOD Standards	OD sample ___ ppm	Interpretation	OD sample ___ ppm	Interpretation	Comments
Standard 1	STD	<1	yellow	-0.14		
Std. 2	STD	<1	yellow			
FC-SS-116	SAMPLE	>1	pale yellow	-0.12		PCBs present @ >1 ppm
FC-SS-121		<10	bright yellow	0.34		
SB-127-3.5-4.5	SAMPLE	<10	bright yellow	.49		
SS-128		<1	bright yellow	.50		
SS-129		<1	yellow	.21		

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Data for SDI PCB EnSys® 12T Soil Test

Operator: Megan Ritchie | Date: 1/24/06 | Location: Calverton Site 6A

Sample ID	ΔOD	OD sample	Interpretation	OD sample	Interpretation	Comments
Standard 1	Standards	0.07 ppm	yellow	___ ppm		
Standard 2	STD	0.07 ppm	yellow			
FC-SB-101-3.54.5	SAMPLE	<10	yellow			
FC-SB-103-3.54.5		<10	yellow			
FC-SB-105-2.535		<10	yellow			
FC-SB-107-0203		<10	yellow			
FC-SB-109-3.54.5		>10 ppm	light yellow			*
FC-SB-102-3.54.5	SAMPLE	>10	light yellow			
FC-SB-104-0102		>10	light yellow			
FC-SB-106-0203		>10	light yellow			
FC-SB-108-2.535		>10	light yellow			
FC-SS-102		>1 ppm	pale yellow			run @ 1 ppm dilution

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Data for SDI PCB EnSys® 12T Soil Test

Operator: Megan Ritchie Date: 1/24/06 Location: Calverton Site 6A

Sample ID	ΔOD Standards	OD sample 0.07 ppm	Interpretation	OD sample ___ ppm	Interpretation	Comments
Std. 1	STD	~~Z~~ <1	yellow			
Std. 2	STD		lighter yellow			DO NOT USE
FC-SS-104	SAMPLE	>1	light yellow			
FC-SS-106		<1	yellow			
FC-SS-108		<1	yellow			
FC-SS-107		>1	light yellow			
FC-SS-105		>1	pale yellow			
FC-SS-101	SAMPLE	<1	bright yellow			
FC-SS-103		<1	bright yellow			
FC-SB-115-2.5-3.5		<10	bright yellow			
FC-SB-114-0102		<10	bright yellow			
FC-SB-113-3.5-4.5		<10	bright yellow			

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Data for SDI PCB EnSys® 12T Soil Test

Operator: Megan Ritchie Date: 1/25/06 Location: Calverton Site 6A

Sample ID	ΔOD Standards	OD sample 6.07 ppm	Interpretation	OD sample ___ ppm	Interpretation	Comments
Std. 1	STD	<1	yellow			
Std. 2	STD	<1	yellow			
SB-116-2.5-3.5	SAMPLE	<10	yellow			
SB-117-02-03		<10	bright yellow			
SB-118-3.5-4.5		<10	bright yellow			
SB-119-3.5-4.5		<10	bright yellow			
SB-120-2.5-3.5		<10	bright yellow			
SB-102-06-07	SAMPLE	<10	bright yellow			
SB-104-06-07		<10	bright yellow			
SB-106-06-07		<10	bright yellow			
SB-108-06-07		<10	bright yellow			
SS-109		<1	bright yellow			* run @ 1 ppm

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APPENDIX B

VOLUME AND MASS CALCULATIONS

CLIENT: NWIRP Calverton, New York		JOB NUMBER: 1610-1110	
SUBJECT: Volume and Mass Calculations (Site 6A, Site 10B, and Onsite Southern Area)			
BASED ON: Attached Figures		DRAWING NUMBER:	
BY: CAR Date: 03-08-06	CHECKED BY: [initials] Date: 3/15/06	APPROVED BY:	DATE:

OBJECTIVE:

Calculate the volume of contaminated groundwater and the mass of dissolved contaminants within the groundwater contaminant plumes associated with Site 6A and Site 10B. Also, estimate the mass of soluble contamination in the soil and free product at the water table that may be contributing to groundwater contamination.

DISCUSSION:

Several phases of investigation have been completed at Site 6A to delineate the extent of the groundwater contamination in the area (See Section 2 of this CMS). Based on the groundwater PRGs for Site 6A, the groundwater COCs include the following:

1,1,1-Trichloroethane	Benzene	Total Xylenes
1,2-Dichlorobenzene	Chloroethane	2-Methylnaphthalene
1,1-Dichloroethane	Ethylbenzene	4-Methylphenol
1,1-Dichloroethene	Toluene	Naphthalene

Several phases of investigation have been completed at Site 6A to delineate the extent of soil contamination and free product (See Section 2 of this report). Based on the soil PRGs for Site 6A, the soil COCs include the following:

Total Xylenes	Naphthalene	Free Product (Fuel-type and CVOCs)
Benzo(a)pyrene	Nitrobenzene	PCB (Aroclor-1260)
Isophorone	2-Nitrophenol	
2-Methylnaphthalene	Phenol	

The Site 6A contaminated groundwater volume and mass calculations are based on the plume map (Figure A-1) provided in this calculation on Page 10 of 15. The Site 6A soil volume and mass calculations utilize Figures A-2 through A-5 on Pages 11 of 15 through 14 of 15.

Several phases of investigation have been completed at Site 10B to delineate the extent of the groundwater contaminant plume in the area (See Section 2 of this CMS). Based on the groundwater PRGs for Site 10B, the groundwater COCs include the following:

Benzene	Toluene
Ethylbenzene	Total Xylenes

The following chemicals were detected in Site 10B groundwater but will be considered as groundwater COCs for the Onsite Southern Area Plume. Separate remedial alternatives will be developed to address this groundwater contamination.

1,1,1-Trichloroethane	1,1-Dichloroethene	Chloroethane	Vinyl Chloride
Freon-113	Bromomethane	Chloroform	
1,1-Dichloroethane	Chlorobenzene	Methylene chloride	

One investigation was completed at Site 10B to delineate extent of soil and free product in the area (See Section 2 of this CMS). TPH DRO concentrations detected in two soil samples were 7,700 mg/kg and 8,500 mg/kg. Based on the ARARs for the remediation of the soil contamination at Site 10B, the soil COCs include the following:

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BASED ON: Attached Figures			DRAWING NUMBER:	
BY: CAR Date: 03-08-06		CHECKED BY: TNA Date: 3/15/06	APPROVED BY:	DATE:

Fuel-related contamination (soil and trace amounts of free product)

The Site 10B contaminated groundwater volume and mass calculations are based on the plume maps (Figures A-1 and A-6) provided in this calculation on Pages 10 of 15 and 15 of 15. The soil volume and mass calculations utilize Figure A-2 on Page 11 of 15.

REFERENCES:

(1) RCRA Facility Investigation for Naval Weapons Industrial Reserve Plant, Calverton, New York. Northern Division, Naval Facilities Engineering Command. Prepared by Halliburton NUS Corporation. August 1995.

(2) RCRA Facility Assessment - Sampling Visit Addendum for Naval Weapons Industrial Reserve Plant Calverton, New York. Northern Division, Naval Facilities Engineering Command. Prepared by C.F. Braun Engineering Corporation. January 1997.

(3) Rough Draft Phase 2 RCRA Facility Investigation for Sites 6A, 10A, 10B, and the Southern Area at NWIRP Calverton, New York. Northern Division, Naval Facilities Engineering Command. Prepared by C.F. Braun Engineering Corporation. January 1998.

(4) Engineering Evaluation/Cost Analysis for Sites 2, 6A, 7, and 10B, Naval Weapons Industrial Reserve Plant, Calverton, New York. Northern Division, Naval Facilities Engineering Command. Prepared by Tetra Tech NUS, Inc. September 1998.

(5) Phase 2 Remedial Investigation for Site 6A - Fuel Calibration Area, Site 10B - Engine Test House, and Southern Area. Naval Weapons Industrial Reserve Plant, Calverton, New York. Northern Division, Naval Facilities Engineering Command. Prepared by Tetra Tech NUS, Inc. July 2001.

(6) Data Summary Report for Site 6A - Fuel Calibration Area and Southern Area. Naval Weapons Industrial Reserve Plant, Calverton, New York. Engineering Field Activity Northeast, Naval Facilities Engineering Command. Prepared by Tetra Tech NUS, Inc. September 2005.

(7) Data Summary Report for Site 6A Petroleum and PCB Delineation. Naval Weapons Industrial Reserve Plant, Calverton, New York. Engineering Field Activity Northeast, Naval Facilities Engineering Command. Prepared by Tetra Tech NUS, Inc. March 2006.

CALCULATION:

(1) Volume of Contaminated Groundwater at Site 6A

To calculate the volume of contaminated groundwater, the area of the plume, the average thickness of the plume, and the porosity of the soil are required.

From Figure A-1 provided on Page 10 of 15 the plume area = 99,700 square feet.

The average plume thickness was estimated to be 30 feet.

Volume of plume is calculated by multiplying the area, thickness, and soil porosity.

Soil porosity is assumed to be: 0.25 fraction (fine/medium sand)

Volume of plume = $\boxed{747,750 \text{ cf}}$

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BY: CAR Date: 03-08-06	CHECKED BY: TAW Date: 3/15/06	APPROVED BY: DATE:

Converting to gallons using a conversion factor of 7.48 gallons per cubic foot;

Volume of plume = $\boxed{5{,}593{,}200 \text{ gallons}}$

(2) Dissolved Mass of COCs in Site 6A Groundwater

After review of the 1997, 2000, and 2005 data sets, it was determined that the maximum concentration of the contaminants detected in 2005 should be used to determine a conservative estimate of the dissolved contamination in Site 6A groundwater. The 2000 data set was assumed to be skewed high and may have included free product. All detected concentrations of organic contaminants will be used in the calculation even though some of them are not COCs. No SVOC analysis of groundwater samples was performed in 2005; therefore, using the maximum concentration may compensate for the lack of SVOC data. Dissolved mass of each constituent is calculated by multiplying the 2005 groundwater concentration by the volume of contaminated groundwater. There are 3.785 liters per gallon.

		Max Conc. (ug/L)	GW Volume (L)	Mass (kg)	Mass (lbs)	
CVOCs	1,1,1-Trichloroethane	12	2.12E+07	0.254	0.559	
	1,1-Dichloroethane	29	2.12E+07	0.614	1.351	
	1,1-Dichloroethene	1.5	2.12E+07	0.032	0.070	
	Chloroethane	20	2.12E+07	0.423	0.932	Subtotal
	Tetrachloroethene	0.23	2.12E+07	0.005	0.011	2.922
VOCs	1,1,2-Trichlorotrifluoroethane	1.1	2.12E+07	0.023	0.051	
	1,2-Dichlorobenzene	0.58	2.12E+07	0.012	0.027	
	2-Butanone	13	2.12E+07	0.275	0.606	Subtotal
	Acetone	6.2	2.12E+07	0.131	0.289	0.973
BTEX	Ethylbenzene	1.1	2.12E+07	0.023	0.051	
	Toluene	3.8	2.12E+07	0.080	0.177	Subtotal
	Total Xylenes	17	2.12E+07	0.360	0.792	1.020
				Total	4.9	

The 2005 contaminant concentrations used in the calculation were taken from Table 2-3 of the CMS.

(3) Estimate Soluble Contaminant Mass/Free Product Remaining in Water Table Fluctuation Zone at Site 6A

The purpose of this calculation is to determine the amount of soluble contaminant mass and free product that continues to act as a source of contamination to the groundwater plume. The contamination likely resulted from the historic presence of floating free product on the water table that has smeared onto the soil as a result of fluctuating groundwater table elevations and sinking into the groundwater zone. Assuming that this free product is located in a smear zone averaging 2 feet thick (range from 1 foot at edge to 4 feet at center near FC-MW-02-S based on boring logs) and it is at a depth of 5 to 7 feet bgs, the volume of soil acting as a source can be determined. Some of the contaminated soil is covered by concrete which was assumed to be approximately 1 foot thick.

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SUBJECT: Volume and Mass Calculations (Site 6A, Site 10B, and Onsite Southern Area)		
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BY: CAR Date: 03-08-06	CHECKED BY: TAM Date: 3/15/06	APPROVED BY: DATE:

Using an assumed soil density based on soil types, and an estimated petroleum concentration within the soil, the mass of petroleum contamination within the soil can be calculated. Figure A-2 provided on Page 11 of 15 shows the extent of the petroleum-contaminated soil at Site 6A based on historical data. Free product has been detected at the water table in the area and due to water table fluctuations the contamination is also smeared on the soil. The extent of contamination was refined in January 2006 (Ref. 7) and the latest extent of the petroleum-contaminated soil is shown on Figure A-3 on Page 12 of 15. The following calculations are based on the information presented on Figure A-3.

Petroleum Area =	41,640 sf	
Avg. Smear Zone Thickness =	2 feet	
Volume of Soil in Smear Zone =	83,280 cf	3084 cy
Volume of Soil Above Smear Zone =	208,200 cf	7711 cy
Volume of Concrete Above Contaminated Soil = (Concrete + Building 231)	8,520 cf	316 cy

The analytical results for a free product sample collected from well FC-MW-02-S (Sample BV) in 1998 are summarized below (Ref. 4). The PCB result is from Well 4 (Sample CG) and was also collected in 1998 (Ref. 4).

			Percent of Free Product
CVOC	1,1,1-Trichloroethane	2,600,000 ug/kg	0.261
	1,1-Dichloroethane	240,000 ug/kg	0.024
BTEX	Ethylbenzene	160,000 ug/kg	0.016
	Toluene	110,000 ug/kg	0.011
	Xylene	1,800,000 ug/kg	0.181
PAH	2-Methylnaphthalene	1,500,000 ug/kg	0.150
	Naphthalene	760,000 ug/kg	0.076
PCB	Aroclor-1260	2,800,000 ug/kg	0.281
	Total =	9,970,000 ug/kg	
	Percent =	0.997	

Based on the analytical results, the percentage of each type of contaminant in 0.997 percent of product.

Percent CVOC =	28.5
Percent BTEX =	20.8
Percent PAH =	22.7
Percent PCB	28.1

Percent Other Pet. Product = 99.0 (Other compounds that are typically part of weathered product are not part of typical analyses)

Considering the analytical data from FC-MW-02S and assuming a current 0.5 percent concentration of free product and a soil density of 110 pounds/cubic feet, the mass of product was estimated.

Mass of free product: 45,800 lbs

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Estimate specific gravity of free product

		Specific Gravity	Weighting Factor	Weighted Sp. Gr.
CVOC	1,1,1-Trichloroethane	1.339	0.0026	0.0035
	1,1-Dichloroethane	1.176	0.0002	0.0003
BTEX	Ethylbenzene	0.867	0.0002	0.0001
	Toluene	0.867	0.0001	0.0001
	Xylene	0.870	0.0018	0.0016
PAH	2-Methylnaphthalene	1.006	0.0015	0.0015
	Naphthalene	1.162	0.0008	0.0009
PCB	Aroclor-1260	1.580	0.0028	0.0044
Other	Petroleum	0.900	0.9900	0.8910
			Specific Gr.	0.9034

It was assumed that since the product is present at the water table that the product mixture had a specific gravity less than water (1.0). The estimated specific gravity was 0.9. Using the estimated specific gravity and a density of 56.2 pounds/cubic feet, the volume of product was estimated.

Volume of petroleum product: 6,100 gallons

The volume and mass of CVOCs, BTEX, PAHs, and PCBs in the free product were estimated using the percentages detected in the free product sample from FC-MW-02S and Well 4.

cVOC	17	gallons	130	pounds
BTEX	13	gallons	100	pounds
PAHs	14	gallons	110	pounds
PCBs	17	gallons	130	pounds
Other Pet. Product	6,039	gallons	45,340	pounds

The order of magnitude of this volume estimate (6,100 gallons) is comparable to the 1,900 gallons of free product that was reportedly removed as of 1996 (Ref. 4); therefore, the estimate is reasonable.

(4) Estimate Volume of PCB-Contaminated Soil at Site 6A

PCBs were detected in free product collected from Well 4 (Sample CG). Additional soil samples were collected in January 2006 adjacent to the former transformer concrete pad near Well 4 to determine the horizontal and vertical extent of PCB-contaminated soil (Ref. 7). The data will be used to calculate volumes of PCB-contaminated soil. The data showed that PCB-contaminated soil is present in the surface soil (0 to 0.5 feet) adjacent to the transformer pad at concentrations ranging from 2.1(FC-SS-105) to 330 mg/kg (FC-SS-102) (see Figures A-4 and A-5). The maximum PCB concentration detected in the subsurface soil was 17 mg/kg (FC-SB-104). Soil contaminated with PCBs at a concentration greater than 50 mg/kg is considered hazardous waste and must be disposed properly. Surface soil with PCBs at a concentration greater than 1 mg/kg and subsurface soil with PCBs at a concentration greater than 10 mg/kg must be remediated to meet remedial goals. The following calculations estimate the amount of PCB-contaminated soil at Site 6A (hazardous and non-hazardous waste) that requires excavation and off-site disposal (see Figures A-4 and A-5).

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BASED ON: Attached Figures		DRAWING NUMBER:
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Area of Surface Soil w/ Conc. > 50 mg/kg = [Area of Pad (192 sf) x 2]	400 sf	
Area of Surface Soil w/ Conc. <50 mg/kg and >1 mg/kg = [Total Area (4,580 sf) - Area of Pad x 2 (400 sf)]	4200 sf	
Average Area of Subsurface Soil w/ Conc.> 10 mg/kg = [(400 sf + 1760 sf) / 2]	1080 sf	
Volume of Surface Soil w/ Conc. > 50 mg/kg = (Assume 1 foot thick, Includes Concrete Pad)	15 cy	(Haz)
Volume of Surface Soil w/ Conc. <50 mg/kg and >1 mg/kg= (Assume 1 foot thick)	156 cy	(Non-Haz)
Volume of Subsurface Soil w/ Conc.<50mg/kg and >10 mg/kg = (Assume 6 feet thick)	240 cy	(Non-Haz)
Volume of Petroleum-Contaminated Soil Remaining After PCB-Contaminated Soil is Removed = [3084 cy - (((1370 sf + 1760 sf) / 2) * 2ft) / 27] (See p. 4 of 15 and Figure A-5)	2970 cy	

(5) Volume of Contaminated Groundwater at Site 10B

Estimate the volume of contaminated groundwater in the Site 10B BTEX source area plume and the Onsite Southern Area Plume. To calculate the volume of contaminated groundwater, the area of the plume, the average thickness of the plume, and the porosity of the soil is required.

(A) From Figure A-1 (Page 10 of 15) the BTEX source area plume = 25,200 square feet.

The average plume thickness was estimated to be 20 feet.

Volume of plume is calculated by multiplying the area, depth, and soil porosity.

Soil porosity is assumed to be: 0.25 fraction (fine/medium sand)

Volume of plume = 126,000 cf

Converting to gallons using a conversion factor of 7.48 gallons per cubic foot;

Volume of plume = 942,500 gallons

(B) From Figure A-6 (Page 15 of 15) the Onsite Southern Area Plume = 3,731,000 square feet.

The average plume thickness was estimated to be 30 feet.

Volume of plume is calculated by multiplying the area, depth, and soil porosity.

Soil porosity is assumed to be: 0.25 fraction (fine/medium sand)

Volume of plume = 27,982,500 cf

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BY: CAR Date: 03-08-06	CHECKED BY: [signature] Date: 3/15/06	APPROVED BY:	DATE:

Converting to gallons using a conversion factor of 7.48 gallons per cubic foot;

Volume of plume = 209,323,700 gallons

(6) Dissolved Mass of COCs in Site 10B Groundwater

Determine the dissolved mass in the BTEX source area and Onsite Southern Area Plume separately. The only available groundwater analytical data was collected in 1997. Based on the natural attenuation modeling performed for the Phase 2 RI (Ref. 5), a conservative biodegradation half-life for most of the contaminants would be 2 years. It is assumed that the BTEX source mass decreased and allowed dissolved concentrations to decrease during the time-frame. It was also assumed that there is no significant continuing source of contamination for the Onsite Southern Area Plume. Current concentrations were estimated using the half-life and 8 years (1997 to 2005).

(A) BTEX Source Area Plume

		1997 Max Conc. (ug/L)	Est. 2005 Max Conc. (ug/L)	GW Volume (L)	Mass (kg)	Mass (lbs)
BTEX	Benzene	1.95	0.12	3.57E+06	0.000	0.001
	Ethylbenzene	1084	67.75	3.57E+06	0.242	0.532
	Toluene	337	21.06	3.57E+06	0.075	0.165
	Total Xylenes	195.5	12.22	3.57E+06	0.044	0.096
					Total	0.79

The 1997 contaminant concentrations used in the calculation were taken from Table 2-4 of the CMS.

(B) Onsite Southern Area Plume

		1997 Max Conc. (ug/L)	Est. 2005 Max Conc. (ug/L)	GW Volume (L)	Mass (kg)	Mass (lbs)	
CVOCs	1,1,1-Trichloroethane	165.5	10.34	7.92E+08	8.195	18.03	
	1,1-Dichloroethane	49.21	3.08	7.92E+08	2.437	5.36	
	1,1-Dichloroethene	187.7	11.73	7.92E+08	9.295	20.45	
	Chloroethane	137.9	8.62	7.92E+08	6.829	15.02	
	Chloroform	15.25	0.95	7.92E+08	0.755	1.66	
	Methylene Chloride	7	0.44	7.92E+08	0.347	0.76	Subtotal
	Vinyl Chloride	59.8	3.74	7.92E+08	2.961	6.51	67.800
VOCs	Freon 113	151.8	9.49	7.92E+08	7.517	16.54	
	Bromodichloromethane	4.1	0.26	7.92E+08	0.203	0.45	
	Bromomethane	353	22.06	7.92E+08	17.480	38.46	
	Chlorobenzene	381	23.81	7.92E+08	18.866	41.51	Subtotal
	Freon 12	0.82	0.05	7.92E+08	0.041	0.09	97.035
					Total	164.8	

The 1997 contaminant concentrations used in the calculation were taken from Table 2-4 of the CMS.

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SUBJECT: Volume and Mass Calculations (Site 6A, Site 10B, and Onsite Southern Area)			
BASED ON: Attached Figures		DRAWING NUMBER:	
BY: CAR Date: 03-08-06	CHECKED BY: TAM Date: 3/15/06	APPROVED BY:	DATE:

(7) Estimate Soluble Contaminant Mass/Free Product Remaining in Water Table Fluctuation Zone at Site 10B - Fuel Calibration Area

The purpose of this calculation is to determine the amount of soluble petroleum contaminant mass and free product that continues to act as a source of contamination to the BTEX source area groundwater plume. No significant source is assumed to remain for the Onsite Southern Area Plume. The petroleum contamination likely resulted from releases from the former UST or spills. Free petroleum product floating on the water table likely smeared onto the soil as a result of fluctuating groundwater table elevations. Trace amounts of free product were detected during the EE/CA (Ref. 4) in two wells (EQ and ES) near the former UST. Petroleum contamination was detected at 8 to 10 feet bgs (ET-SB01-0810 at water table) just south of the former UST during the RFA Addendum (Ref. 2). Petroleum contamination was also detected at 4 to 6 feet bgs (ET-TW/SB-01A and ET-TW/SB-03A) below the concrete pad surrounding the Engine Test House (Ref. 4). Assuming that this free petroleum product is located in a smear zone averaging 2 feet thick and that the residual petroleum has adsorbed onto these soils, the volume of soil acting as a source can be determined.

Using an assumed soil density based on soil types, and an estimated petroleum concentration within the soil, the mass of petroleum contamination within the soil can be calculated. Based on Figure A-2 (Page 11 of 15) which shows the extent of the soil source area at Site 10B (10,330 square feet), a volume of soil contamination can be estimated. Assume soil from 4 to 6 feet bgs underneath of the concrete is contaminated and that soil from 8 to 10 feet bgs outside of the concrete is contaminated. Based on boring logs, the concrete is approximately 1 foot thick.

Area =	10,330 sf	
Smear Zone thickness =	2 foot	
Volume of Soil in Smear Zone =	20,660 cf	765 cy
Area of Concrete Pad =	6,500 sf	
Volume of Soil Above Smear Zone Beneath Concrete Pad =	19,500 cf	722 cy
Volume of Soil Above Smear Zone Outside Concrete Pad =	30,640 cf	1,135 cy
Volume of Concrete Covering Contaminated Soil =	6,500 cf	241 cy

TPH DRO concentrations detected in two soil samples were 7,700 mg/kg and 8,500 mg/kg. Therefore, the average soil concentration was estimated to be 8,100 mg/kg (0.81 percent). At an assumed soil density of 110 pounds/cubic feet and an assumed petroleum product concentration of 0.81 percent, the mass of product was estimated.

Mass of petroleum product:	18,400 lbs

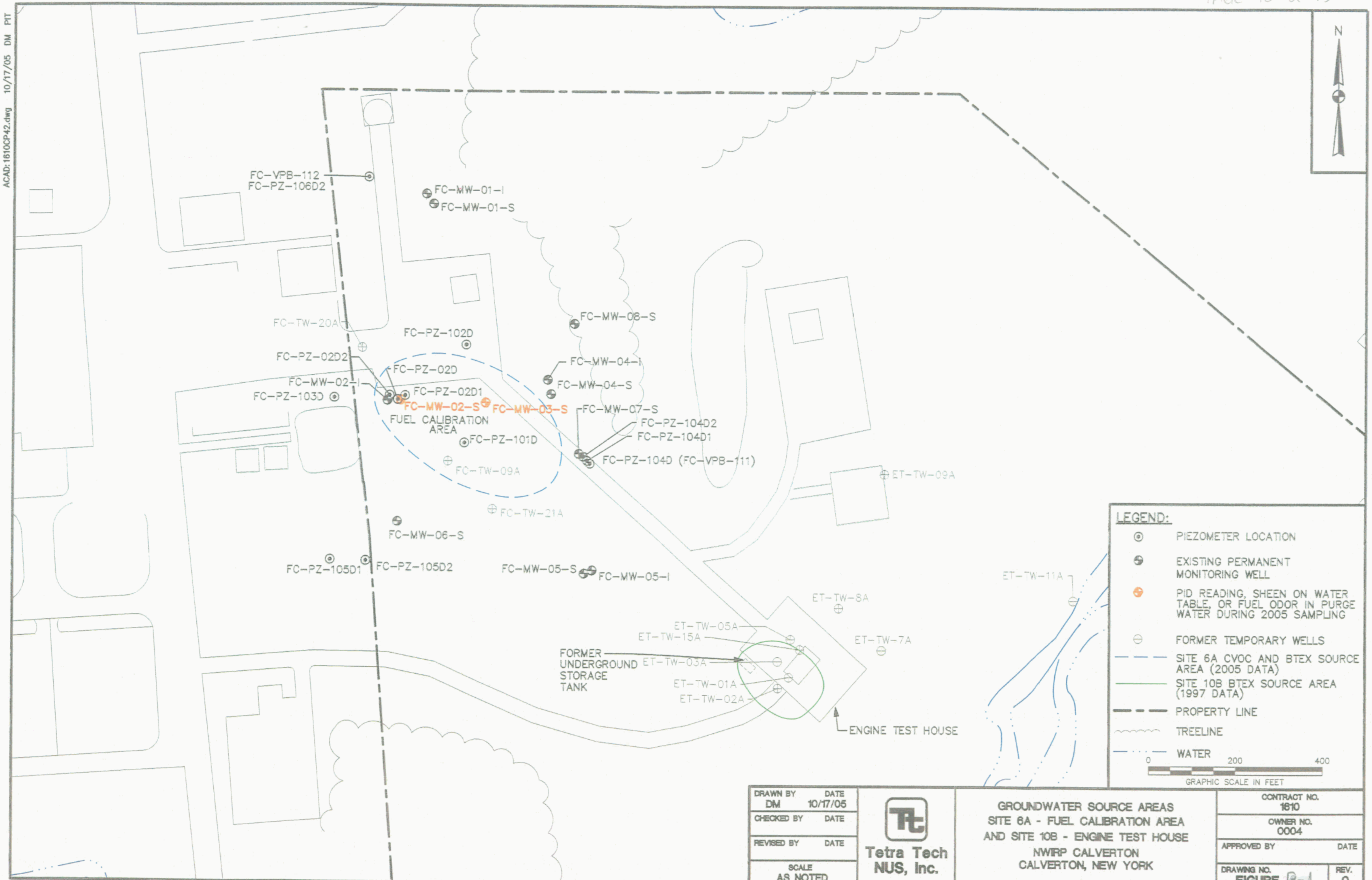
Since the product is present at the water table, assume the product is mainly fuel with minor amounts of solvents and has a specific gravity of 0.90 (less than water) and a density of 56.2 pounds/cubic feet. The volume of product was estimated.

CLIENT: NWIRP Calverton, New York		JOB NUMBER: 1610-1110
SUBJECT: Volume and Mass Calculations (Site 6A, Site 10B, and Onsite Southern Area)		
BASED ON: Attached Figures		DRAWING NUMBER:
BY: CAR Date: 03-08-06	CHECKED BY: TMA Date: 3/15/06	APPROVED BY: DATE:

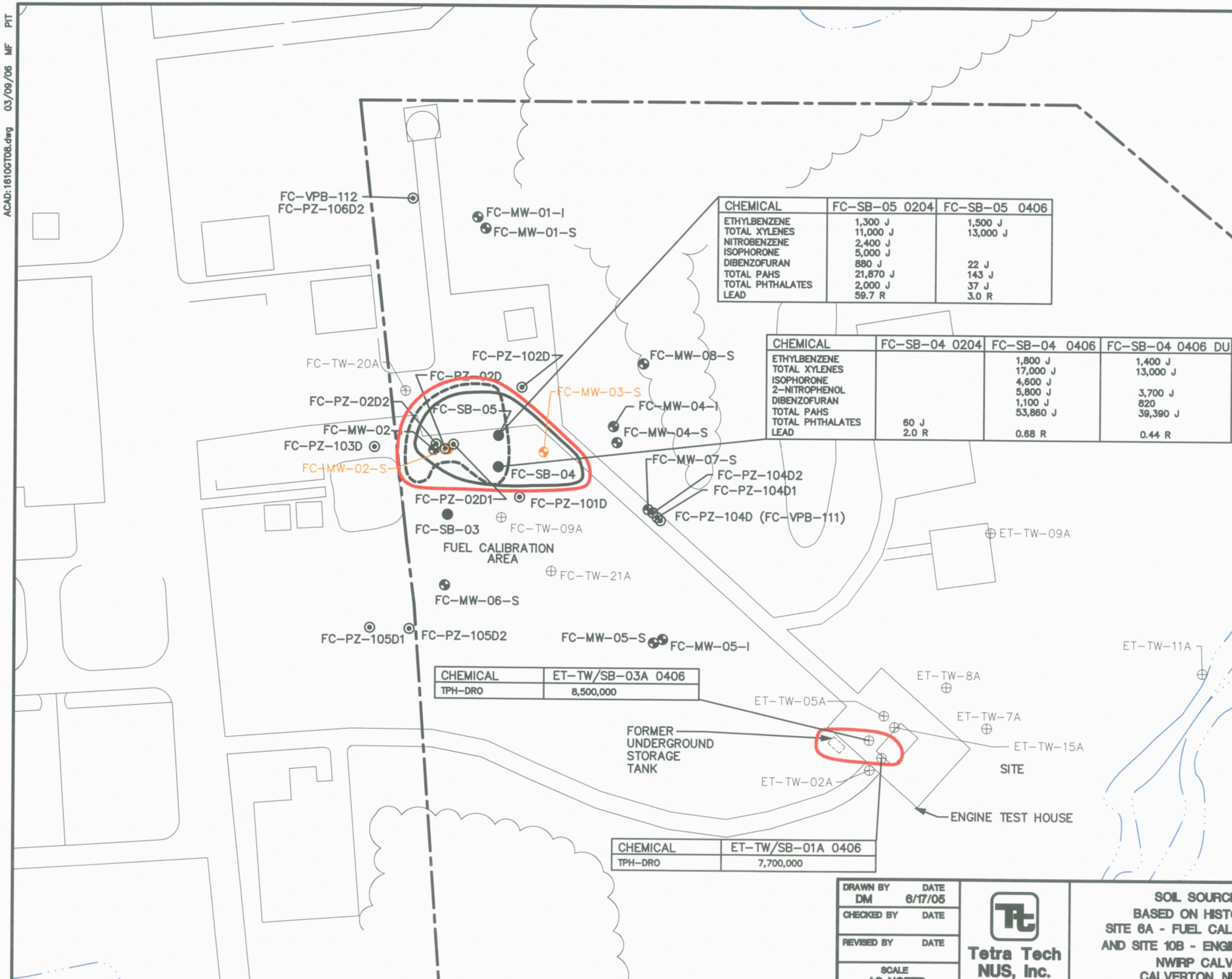
Volume of petroleum product: 2,450 gallons

The order of magnitude of this volume estimate is comparable to the free product estimate for Site 6A; therefore, the estimate appears to be reasonable.

ACAD:1610CP42.dwg 10/17/05 DM PIT



FORM CADD NO. TTNUS-BH.DWG - REV 1 - 9/10/98



CHEMICAL	FC-SB-05 0204	FC-SB-05 0406
ETHYLBENZENE	1,300 J	1,500 J
TOTAL XYLENES	11,000 J	13,000 J
NITROBENZENE	2,400 J	
ISOPHORONE	5,000 J	
DIBENZOFURAN	880 J	22 J
TOTAL PAHS	21,870 J	143 J
TOTAL PHTHALATES	2,000 J	37 J
LEAD	59.7 R	3.0 R

CHEMICAL	FC-SB-04 0204	FC-SB-04 0406	FC-SB-04 0406 DU
ETHYLBENZENE		1,800 J	1,400 J
TOTAL XYLENES		17,000 J	13,000 J
ISOPHORONE		4,600 J	
2-NITROPHENOL		5,800 J	3,700 J
DIBENZOFURAN		1,100 J	820
TOTAL PAHS		53,860 J	39,390 J
TOTAL PHTHALATES	60 J		
LEAD	2.0 R	0.68 R	0.44 R

CHEMICAL	ET-TW/SB-03A 0406
TPH-DRO	8,500,000

CHEMICAL	ET-TW/SB-01A 0406
TPH-DRO	7,700,000

LEGEND:

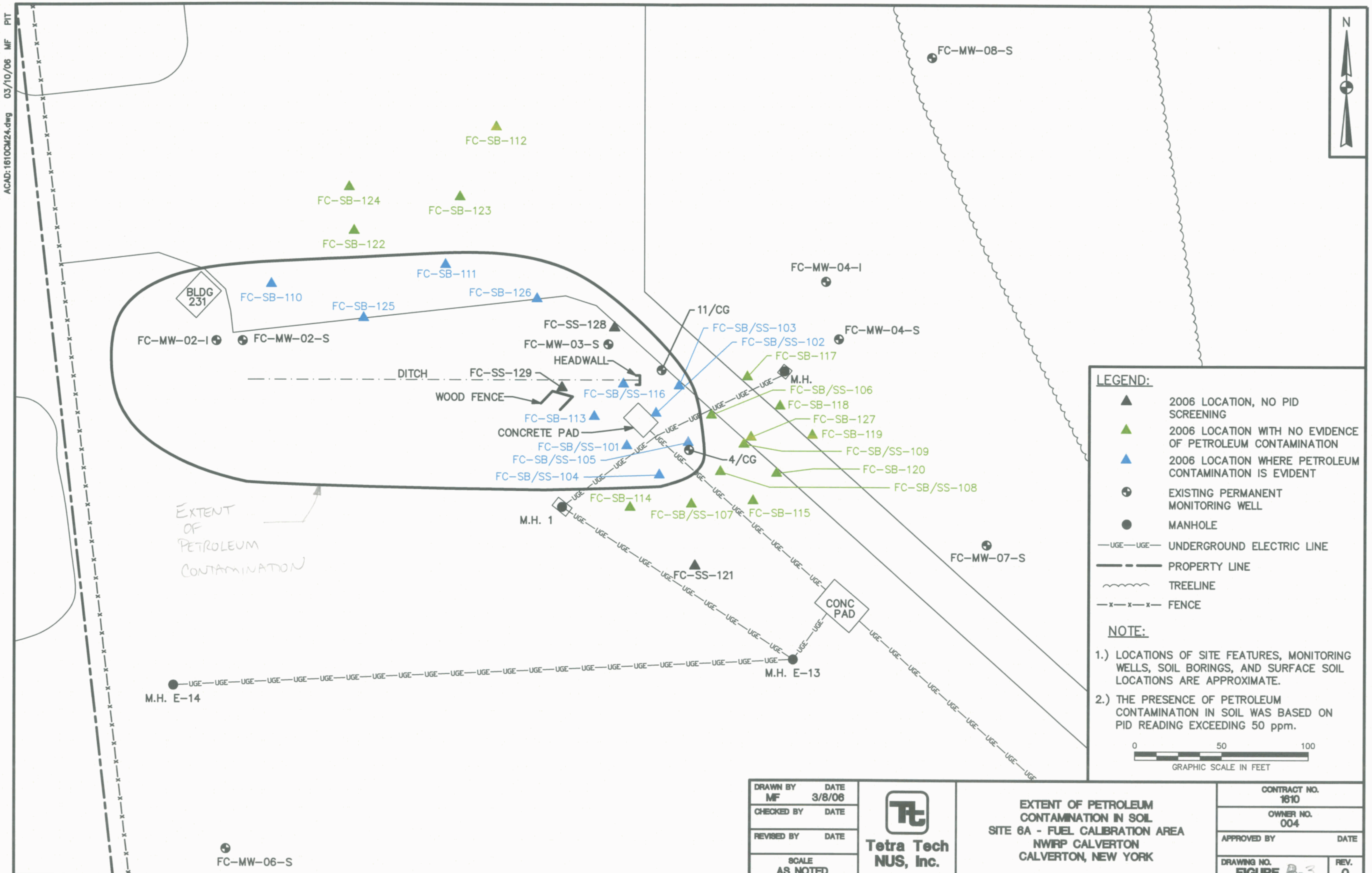
- SOIL BORING LOCATION
- PIEZOMETER LOCATION
- EXISTING PERMANENT MONITORING WELL
- PID READING, SHEEN ON WATER TABLE, OR FUEL ODOR IN PURGE WATER DURING 2005 SAMPLING
- FORMER TEMPORARY WELLS
- 10 µg/L (MICROGRAMS PER LITER) CHLORINATED VOC SOIL GAS CONTOUR FROM RFI (HNUS, 1995)
- 10 µg/L (MICROGRAMS PER LITER) BTEX SOIL GAS CONTOUR FROM (HNUS, 1995)
- LIMIT OF SOIL CONTAMINATION (SOURCE AREA)
- PROPERTY LINE
- TREELINE
- WATER

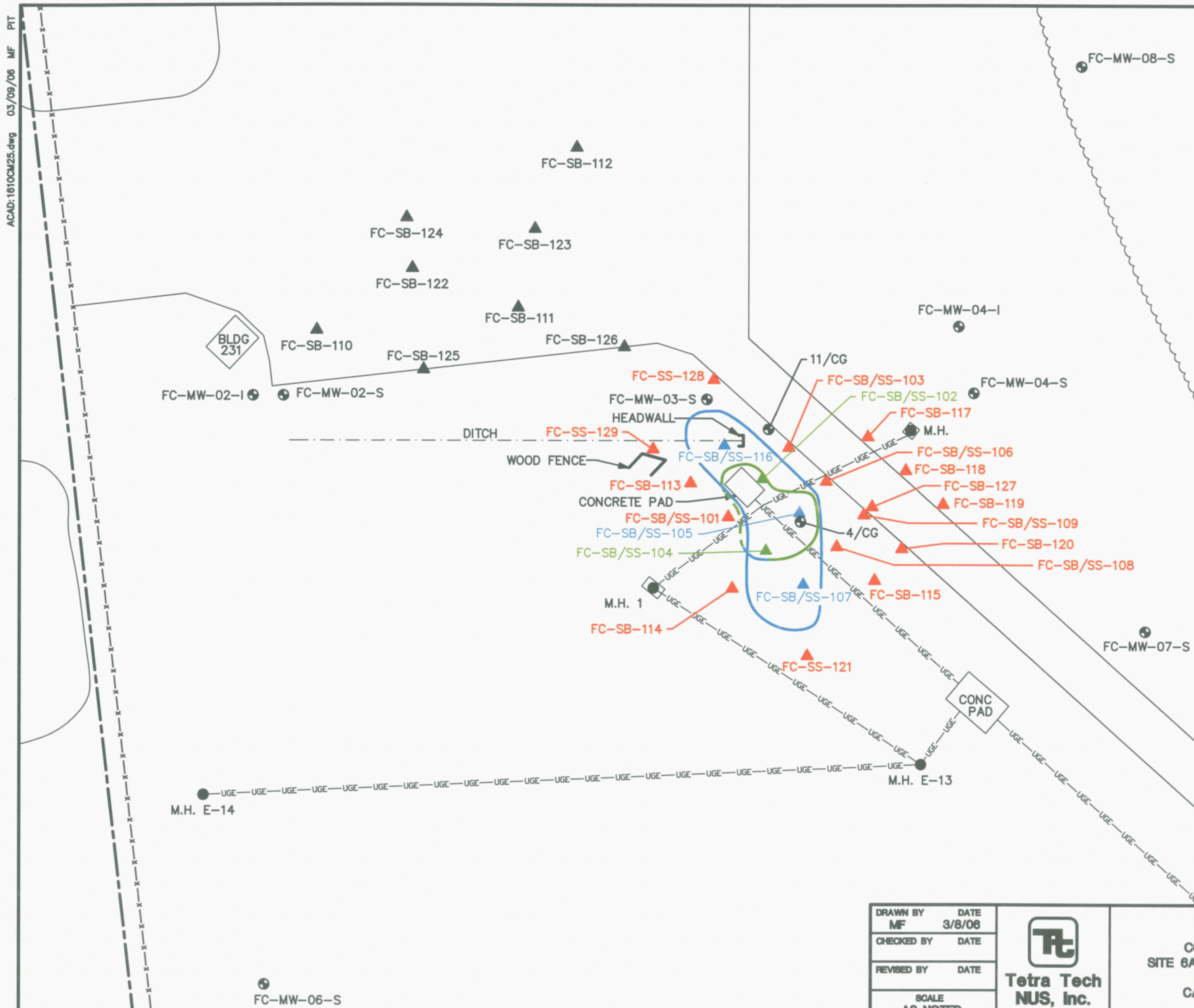
NOTE: SITE 6A AND SITE 10B SOIL DATA PRESENTED IN TAGS WERE TAKEN FROM RFI (HNUS, 1995) AND PHASE 2 RFI (CF BRAUN, 1998), RESPECTIVELY, AND UNITS ARE µg/kg (MICROGRAMS PER KILOGRAM).

0 200 400
GRAPHIC SCALE IN FEET

DRAWN BY DM	DATE 6/17/05	Tetra Tech NUS, Inc.	SOIL SOURCE AREA BASED ON HISTORIC DATA SITE 6A - FUEL CALIBRATION AREA AND SITE 10B - ENGINE TEST HOUSE NWIRP CALVERTON CALVERTON, NEW YORK	CONTRACT NO. 1610	
CHECKED BY	DATE			OWNER NO. 0004	
REVISED BY	DATE			APPROVED BY	DATE
SCALE AS NOTED				DRAWING NO. FIGURE B-2	REV. 0

ACAD: 1610GT08.dwg 03/09/06 MF PIT


ACAD:1610CM24.dwg 03/10/06 MF PIT
N
FC-MW-08-S
FC-SB-112
FC-SB-124
FC-SB-123
FC-SB-122
FC-SB-111
BLDG 231
FC-SB-110
FC-SB-125
FC-SB-126
FC-MW-04-I
11/CG
FC-SS-128
FC-SB/SS-103
FC-SB/SS-102
FC-MW-04-S
FC-MW-02-I
FC-MW-02-S
FC-MW-03-S
HEADWALL
FC-SB-117
DITCH
FC-SS-129
M.H.
WOOD FENCE
FC-SB/SS-116
FC-SB/SS-106
FC-SB-118
FC-SB-113
FC-SB-127
CONCRETE PAD
FC-SB-119
FC-SB/SS-101
FC-SB/SS-109
FC-SB/SS-105
4/CG
FC-SB-120
FC-SB/SS-104
FC-SB/SS-108
FC-SB-114
M.H. 1
FC-SB/SS-107
FC-SB-115
EXTENT OF PETROLEUM CONTAMINATION
FC-MW-07-S
FC-SS-121
CONC PAD
M.H. E-13
M.H. E-14
FC-MW-06-S
UGE
LEGEND:
2006 LOCATION, NO PID SCREENING
2006 LOCATION WITH NO EVIDENCE OF PETROLEUM CONTAMINATION
2006 LOCATION WHERE PETROLEUM CONTAMINATION IS EVIDENT
EXISTING PERMANENT MONITORING WELL
MANHOLE
—UGE—UGE— UNDERGROUND ELECTRIC LINE
PROPERTY LINE
TREELINE
—x—x—x— FENCE
NOTE:
1.) LOCATIONS OF SITE FEATURES, MONITORING WELLS, SOIL BORINGS, AND SURFACE SOIL LOCATIONS ARE APPROXIMATE.
2.) THE PRESENCE OF PETROLEUM CONTAMINATION IN SOIL WAS BASED ON PID READING EXCEEDING 50 ppm.
0 50 100
GRAPHIC SCALE IN FEET
DRAWN BY MF
DATE 3/8/06
CHECKED BY
DATE
REVISED BY
DATE
SCALE AS NOTED
Tetra Tech NUS, Inc.
EXTENT OF PETROLEUM CONTAMINATION IN SOIL
SITE 6A - FUEL CALIBRATION AREA
NWIRP CALVERTON
CALVERTON, NEW YORK
CONTRACT NO. 1610
OWNER NO. 004
APPROVED BY
DATE
DRAWING NO. FIGURE B-3
REV. 0



LEGEND:

- EXTENT OF PCB CONTAMINATION IN SUB-SURFACE SOIL (GROUNDWATER INTERFACE)
- EXTENT OF PCB CONTAMINATION IN SURFACE SOIL
- ▲ 2006 LOCATION, NO PCB SAMPLING
- ▲ 2006 LOCATION WHERE PCB CONCENTRATIONS EXCEED SCREENING CRITERIA (SURFACE SOIL ONLY)
- ▲ 2006 LOCATION WHERE PCB CONCENTRATIONS EXCEED SCREENING CRITERIA (SURFACE AND SUBSURFACE SOIL)
- ▲ 2006 LOCATION WHERE PCB CONCENTRATIONS ARE BELOW SCREENING CRITERIA (SURFACE AND SUBSURFACE SOIL)
- EXISTING PERMANENT MONITORING WELL
- MANHOLE
- —UGE—UGE— UNDERGROUND ELECTRIC LINE
- PROPERTY LINE
- TREELINE
- —x—x—x— FENCE

NOTE:

1.) LOCATIONS OF SITE FEATURES, MONITORING WELLS, SOIL BORINGS, AND SURFACE SOIL LOCATIONS ARE APPROXIMATE.

2.) THE PRESENCE OF PCB CONTAMINATION IN SOIL WAS BASED ON SAMPLE RESULTS EXCEEDING 1 ppm IN SURFACE SOIL AND 10 ppm IN SUBSURFACE SOIL.

0 50 100

GRAPHIC SCALE IN FEET

DRAWN BY MF	DATE 3/8/06	Tetra Tech NUS, Inc.	EXTENT OF PCB CONTAMINATION IN SOIL SITE 6A - FUEL CALIBRATION AREA NWIRP CALVERTON CALVERTON, NEW YORK	CONTRACT NO. 1610
CHECKED BY	DATE			OWNER NO. 004
REVISED BY	DATE			APPROVED BY / DATE
SCALE AS NOTED				DRAWING NO. FIGURE B-4 / REV. 0

TETRA TECH NUS, INC. **CALCULATION WORKSHEET** PAGE 14 OF 15

CLIENT: NAVY - CALVERTON	JOB NUMBER: 1610
SUBJECT: CONCEPTUAL MODEL OF PCB CONTAMINATION AT SITE 6A TRANSFORMER	
BASED ON: NEW FIELD DATA	DRAWING NUMBER: B-5
BY: CAR 3/8/06	CHECKED BY:
APPROVED BY:	DATE:

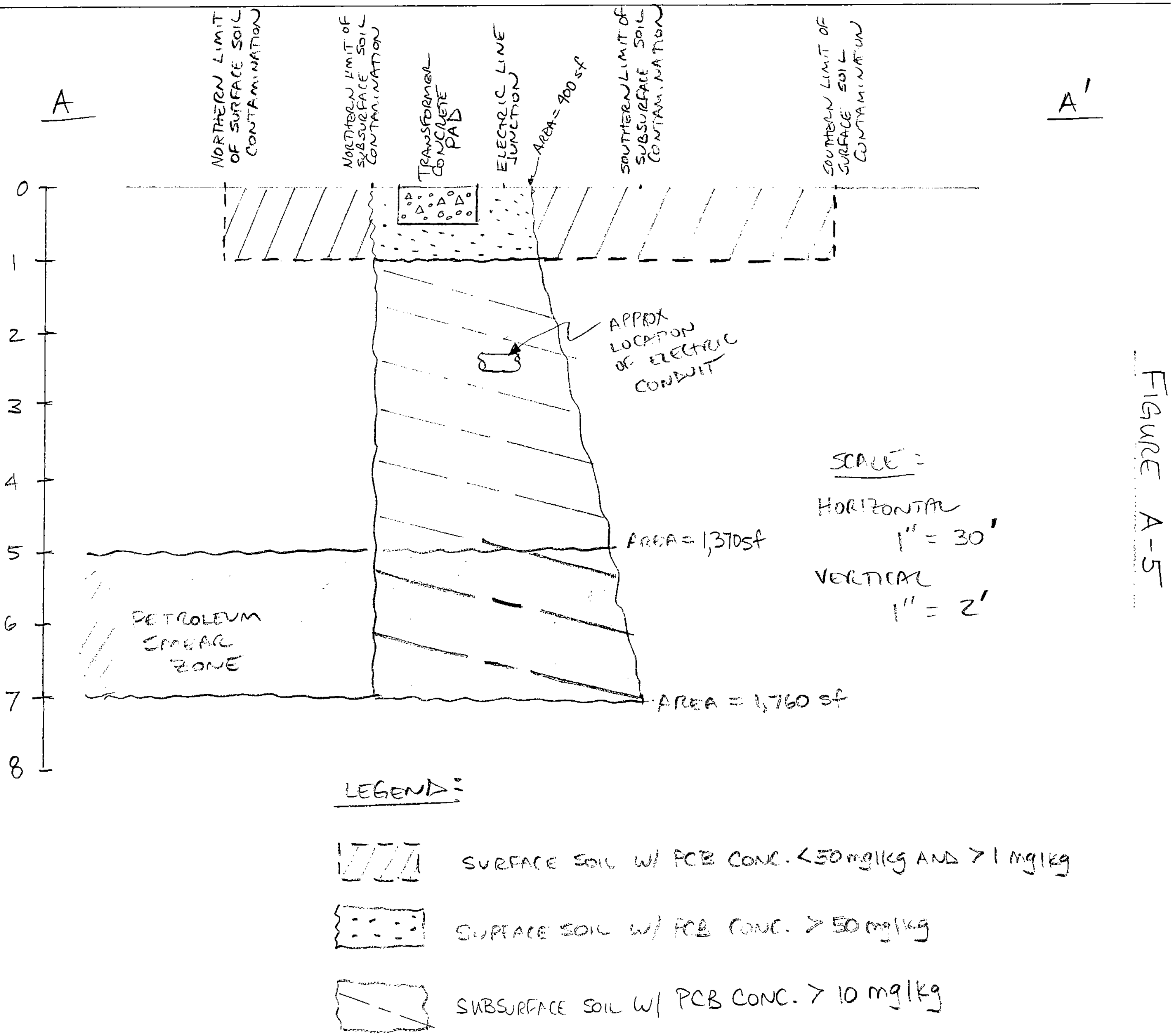
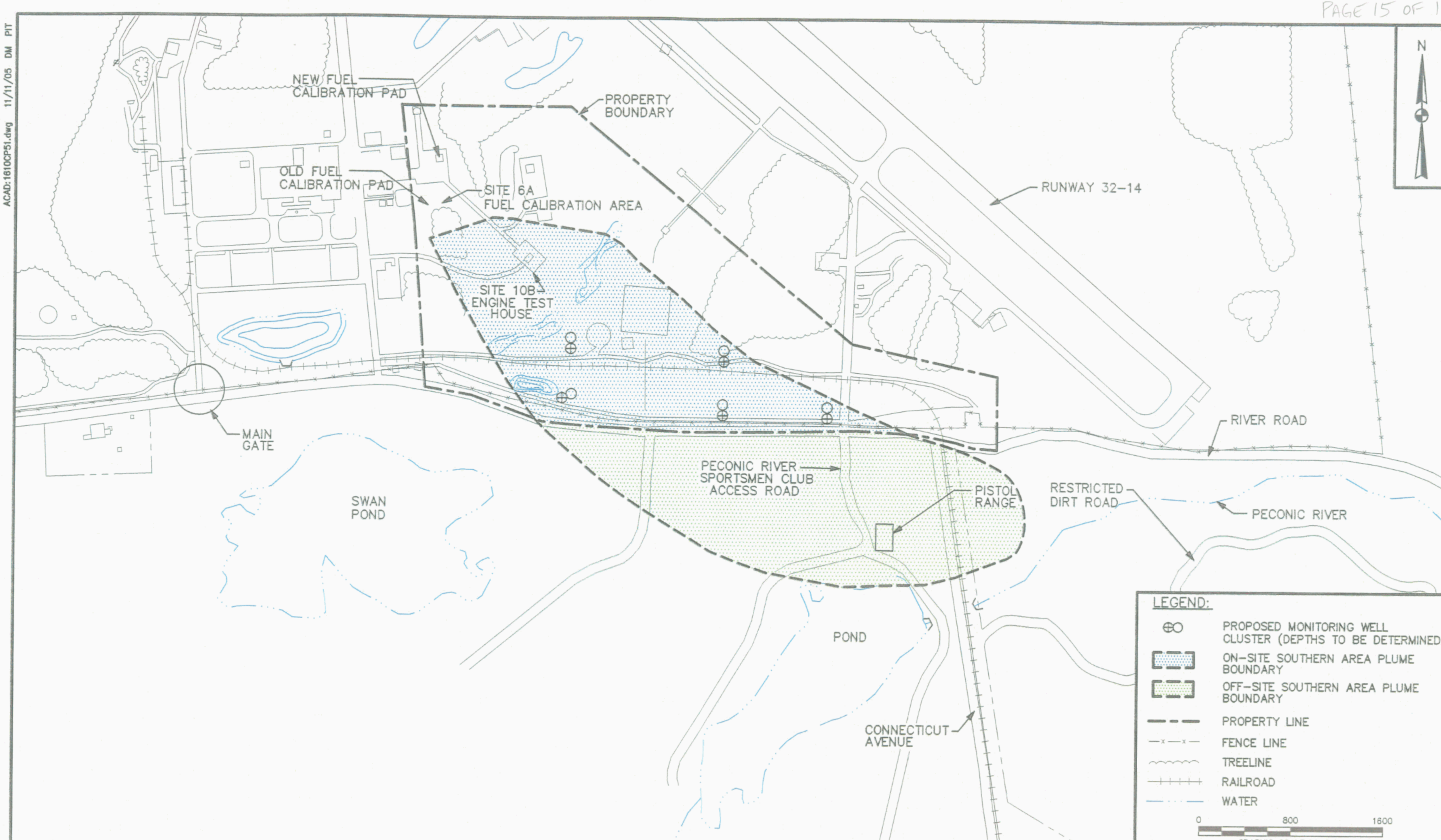


FIGURE A-5



DRAWN BY HJB	DATE 10/18/05	Tetra Tech NUS, Inc.	ALTERNATIVE OSAGP2 - MONITORING WELL NETWORK ON-SITE SOUTHERN AREA PLUME NWIRP CALVERTON CALVERTON, NEW YORK	CONTRACT NO. 1610	
CHECKED BY	DATE			OWNER NO. 0004	
REVISED BY	DATE			APPROVED BY	DATE
SCALE AS NOTED				DRAWING NO. FIGURE B-6	REV. 0

APPENDIX C

ALTERNATIVE CALCULATIONS

C.1 - INVESTIGATION, MONITORING, O&M, AND WASTE DISPOSAL (ALL ALTERNATIVES)

C.2 - THERMAL TREATMENT (ALTERNATIVE S4)

C.3 - IN-SITU CHEMICAL OXIDATION (ALTERNATIVE S7)

C.4 - AIR SPARGING/SOIL VAPOR EXTRACTION (ALTERNATIVES S5 AND SAGW4)

C.5 - GROUNDWATER PUMP AND TREAT (ALTERNATIVES SAGW3 AND OSAGP3)

C.6 - BIOSTIMULATION (ALTERNATIVES SAWG5 AND OSAGP4)

Note: Areas and volumes presented in the Appendix C calculations were not updated to reflect the results of the January 2006 Site 6A Data Gap Investigation. It was judged that changing the areas and volumes within the calculations presented in Appendix C would not significantly affect the cost estimates presented in Appendix D. Results of the January 2006 Site 6A Data Gap Investigation have been reflected in the volume and mass calculations presented in Appendix B. Changes in the Appendix B calculations have been reflected in the cost estimates presented in the appendix D because of their significance to the alternative costing.

C.1 - INVESTIGATION, MONITORING, O&M, AND WASTE DISPOSAL

TETRA TECH NUS, INC. CALCULATION WORKSHEET

CLIENT: NWIRP Calverton, New York		JOB NUMBER: 112GN1610 0000.1110	
SUBJECT: Site 6A, Site 10B, and Onsite Southern Area Soil Alternatives (S2, S3, S4, S5, S6, and S7) Incremental Costs			
BASED ON:		DRAWING NUMBER:	
BY: NJB Date: 10/21/05	CHECKED BY: Date:	MODIFIED BY: JLM	DATE: 12-29-05

Alt S2, S3, S4, S5, S6, and S7 (Well) Pre-Design Investigation Soil Sample Analysis

VOCs	$ 125.00
SVOCs	$ 225.00
PAHs	$ 150.00
Pesticides	$ 125.00
PCBs	$ 75.00
DRO	$ 95.00
TCLP/Metals	$ 175.00
Subtotal	$ 970.00
QA (30%)	$ 291.00
Total	**$ 1,261.00**

Alt S7 (ChemOx) Soil Sample Analysis

VOCs	$ 125.00
SVOCs	$ 225.00
PAHs	$ 150.00
DRO	$ 95.00
Subtotal	$ 595.00
QA (30%)	$ 178.50
Total	**$ 773.50**

Alt S3, S4, S5, S6, and S7 (Well) Confirmation Soil Sample Analysis

VOCs	$ 125.00	
SVOCs	$ 225.00	
PAHs	$ 150.00	
Pesticides	$ 125.00	
PCBs	$ 75.00	
DRO	$ 95.00	
Subtotal	$ 795.00	
x 1.5	$ 1,192.50	Higher cost for quick turnaround
QA (30%)	$ 357.75	
Total	**$ 1,550.25**	

TETRA TECH NUS, INC. CALCULATION WORKSHEET

CLIENT: NWIRP Calverton, New York		JOB NUMBER: 112GN1610 0000.1110	
SUBJECT: Site 6A, Site 10B, and Onsite Southern Area Soil Alternatives (S2, S3, S4, S5, S6, and S7) Incremental Costs			
BASED ON:		DRAWING NUMBER:	
BY: NJB Date: 10/21/05	CHECKED BY: Date:	MODIFIED BY: JLM	DATE: 12-29-05

Alt S5 Annual Soil Sample Analysis

VOCs	$	125.00
SVOCs	$	225.00
PAHs	$	150.00
PCBs	$	75.00
DRO	$	95.00
Subtotal	$	670.00
QA (30%)	$	201.00
Total	$	871.00
8 Samples =	**$**	**6,968.00**

PCBs	$	75.00
QA (30%)	$	22.50
Total	$	97.50
4 Samples =	**$**	**390.00**

Alt S6 Annual Soil Sample Analysis

VOCs	$	125.00
SVOCs	$	225.00
PAHs	$	150.00
PCBs	$	-
DRO	$	95.00
Subtotal	$	595.00
QA (30%)	$	178.50
Total	$	773.50
8 Samples =	**$**	**6,188.00**

Alts S2 and S5 Annual Costs

Soil Labor - Alt S2 Every 5 Years, Alt S5 Years 1 through 4

Collect 8 samples, local labor (say 2 people for 1 day)
Prep, collect supplies, forms, etc. (say 2 people for half day)
Total = 2 people for 1.5 days (10 hours per day)

Cost Item	Number	Rate/Hour	Hours	Cost/Day	Days	Total Cost
Supervisor	1	$ 40	15			$ 600
Laborer	1	$ 32	15			$ 480
Cars & Gas	1			$ 70	1	$ 70
Ship, Supplies	1			$ 300	1	$ 300
Subtotal						$ 1,450
DPT Rig Mob/Demob						$ 3,000
DPT $20 per foot x 4 samples x 2 sites x 10 ft/hole						$ 1,600
TOTAL COST						**$ 6,050**

Soil Labor - Alt S5 Years 5 through 30

Collect 4 samples, local labor (say 2 people for 1 day)
Prep, collect supplies, forms, etc. (say 2 people for half day)
Total = 2 people for 1.5 days (10 hours per day)

TETRA TECH NUS, INC. **CALCULATION WORKSHEET**

CLIENT: NWIRP Calverton, New York			JOB NUMBER: 112GN1610 0000.1110	
SUBJECT: Site 6A, Site 10B, and Onsite Southern Area Soil Alternatives (S2, S3, S4, S5, S6, and S7) Incremental Costs				
BASED ON:			DRAWING NUMBER:	
BY: NJB	CHECKED BY:		MODIFIED BY: JLM	DATE: 12-29-05
Date: 10/21/05	Date:			

Cost Item	Number	Rate/Hour	Hours	Cost/Day	Days	Total Cost
Supervisor	1	$ 40	15			$ 600
Laborer	1	$ 32	15			$ 480
Cars & Gas	1			$ 70	1	$ 70
Ship, Supplies	1			$ 300	1	$ 300
Subtotal						$ 1,450
DPT Rig Mob/Demob						$ 3,000
DPT $20 per foot x 4 samples x 10 ft/hole						$ 800
TOTAL COST						**$ 5,250**

Alts S5 and S7 Air Monitoring

Air Monitoring (Tedlar Bags) $ 150 each
Assume 2 samples every 12 months = **$ 3,600**

Air Monitoring Labor
Assume $30/hour for 8 hours each month = **$ 2,880**

Alt S5 Operation & Maintenance Costs

Electrical Costs:

Site 6A

Extraction Pump	15 HP
x 0.7457 x 24 x 365 =	97,985 kWh
Transfer Pump	1 HP
x 0.7457 x 10 x 52	388 kwH
Total	**98,373 kWh**

Site 10B

Extraction Pump	3 HP
x 0.7457 x 24 x 365 =	19,597 kWh
Transfer Pump	1 HP
x 0.7457 x 10 x 52	388 kWh
Total	**19,985 kWh**

CLIENT: NWIRP Calverton, New York	JOB NUMBEI 1610-1110
SUBJECT: Alt SAGW2, SAGW 3, and SAGW 4 Groundwater Testing Costs (Site 6A, Site 10B, and Onsite Southern Area)	
BASED ON:	DRAWING NUMBER:
BY: NJB Date: 10/21/05 / CHECKED BY: Date:	APPROVED BY: DATE:

Site 6A - 8 wells plus Site 10B - 4 wells
Annual Costs
Initial rounds

water - collect 12 samples from 12 wells local labor - say 2 people for 3 days
half day - prep, collect supplies, forms, etc.

total: 2 people 3 1/2 days, 10 hour days

cost item	number	cost/hr	hours	cost/day	days	total cost	
supervisor	1	$40	35			$1,400	
laborer	1	$32	35			$1,120	
cars & gas	1			$70	3	$210	
ship, supplies	1			$300	3	$900	
TOTAL COST				Years 2 through 10		**$3,630**	per round
					Year 1	**$14,520**	4 quarters

Analysis/Water

parameter	medium	unit cost
TCL VOCs	water	$ 100.00
TCL SVOCs	water	$ 225.00
PAHs	water	$ 150.00
anions (chloride, sulfate, nitrate, nitrite)	water	$ 45.00
sulfide		$ 25.00
methane, ethene, ethane	water	$ 125.00
Lab Subtotal		$ 670.00
QA 30%		$ 201.00
Lab Total		$ 871.00
field test kit	water	$ 50.00
Total		$ 921.00

$	920.00	x 12 =	$	**11,052**	Years 2 through 10, Alt SAGW2 Years 2 through 9, Alt SAGW3 Years 2 through 4, Alt SAGW4 Years 4 through 6, Alt SAGW5
$	11,052.00	x 4 quarters =	$	**44,208**	Year 1, Alt SAGW2, SAGW3, SAGW4 Years 1 thru 3, Alt SAGW5

CLIENT: NWIRP Calverton, New York		JOB NUMBEI 1610-1110
SUBJECT: Alt SAGW2, SAGW 3, and SAGW 4 Groundwater Testing Costs (Site 6A, Site 10B, and Onsite Southern Area)		
BASED ON:		DRAWING NUMBER:
BY: NJB Date: 10/21/05	CHECKED BY: Date:	APPROVED BY: DATE:

Annual Sampling - Years 11 through 30, Alt SAGW2 & years 10 thru 30 SAGW3

Site 10B - 4 wells

Performance Sampling

water - collect 8 samples from 8 wells local labor - say 2 people for 2 days
half day - prep, collect supplies, forms, etc.

total: 2 people 2 1/2 days, 10 hour days

cost item	number	cost/hr	hours	cost/day	days	total cost	
supervisor	1	$40	25			$1,000	
laborer	1	$32	25			$800	
cars & gas	1			$70	2	$140	
ship, supplies	1			$300	2	$600	
TOTAL COST						**$2,540**	per round

Analysis/Water

parameter	medium	unit cost
TCL VOCs	water	$ 100.00
TCL SVOCs	water	$ 225.00
PAHs	water	$ 150.00
anions (chloride, sulfate, nitrate, nitrite)	water	$ 45.00
sulfide		$ 25.00
methane, ethene, ethane	water	$ 125.00
Lab Subtotal		$ 670.00
QA 30%		$ 201.00
Lab Total		$ 871.00
field test kit	water	$ 50.00
Total		$ 921.00

$ 921.00 x 8 = **$ 7,368.00**

CLIENT: NWIRP Calverton, New York		JOB NUMBEI 1610-1110	
SUBJECT: Alt SAGW3 & OSAGP3 Incremental Costs (Site 6A, Site 10B, and Onsite Southern Area)			
BASED ON:		DRAWING NUMBER:	
BY: NJB Date: 10/21/05	CHECKED BY: Date:	APPROVED BY:	DATE:

O&M Costs

Analysis - Influent/Effluent

parameter	medium	unit cost
TCL VOCs	water	$ 100.00
TCL SVOCs	water	$ 225.00
PAHs	water	$ 150.00
Lab Subtotal		$ 475.00
QA 30%		$ 142.50
Lab Total		**$ 617.50**

Electrical Costs:

Site 6A

Extraction Pumps, 4 @ 0.5	2 HP	
Mixer	1.25 HP	
Cent Pump	5 HP	(only 1 operating at a time)
Blower	2 HP	estimate
Total	10.25 HP	
x 0.7457 x 24 x 365 =	66,956 kWh	

Site 10B

Extraction Pumps, 2 @ 0.5	1 HP	
Mixer	0.6 HP	
Cent Pump	3 HP	(only 1 operating at a time)
Blower	1 HP	???
Total	5.6 HP	
x 0.7457 x 24 x 365 =	36,581 kWh	

Onsite Southern Area Plume

Extraction Pumps, 5 @ 1.5	7.5 HP	
Mixer	3.6 HP	
Cent Pump	20 HP	(only 2 operating at a time)
Blower	4 HP	
Total	35.1 HP	
x 0.7457 x 24 x 365 =	229,285 kWh	

CLIENT: NWIRP Calverton, New York	JOB NUMBEI 1610-1110	
SUBJECT: Alts OSAGP2, OSAGP3, and OSAGP4 Groundwater Testing Costs (Site 6A, Site 10B, and Onsite Southern Area)		
BASED ON:	DRAWING NUMBER:	
BY: NJB Date: 10/21/05	CHECKED BY: Date:	APPROVED BY: DATE:

10 wells

water - collect 10 samples from 10 wells local labor - say 2 people for 2 1/2 days
half day - prep, collect supplies, forms, etc.

total: 2 people 3 days, 10 hour days

cost item	number	cost/hr	hours	cost/day	days	total cost	
supervisor	1	$40	30			$1,200	
laborer	1	$32	30			$960	
cars & gas	1			$70	3	$210	
ship, supplies	1			$300	3	$900	
TOTAL COST			Alt OSAGP2: Years 2 through 30			**$3,270**	per round
			Alt OSAGP3: Years 2 through 11			**$3,270**	per round
			Alt OSAGP4: Years 2 through 10			**$3,270**	per round
			Year 1			**$13,080**	4 quarters

Analysis/Water

parameter	medium	unit cost
TCL VOCs	water	$ 100.00
TCL SVOCs	water	$ 225.00
PAHs	water	$ 150.00
anions (chloride, sulfate, nitrate, nitrite)	water	$ 45.00
sulfide		$ 25.00
methane, ethene, ethane	water	$ 125.00
Lab Subtotal		$ 670.00
QA 30%		$ 201.00
Lab Total		$ 871.00
field test kit	water	$ 50.00
Total		$ 921.00

$ 921.00	x 10 =	**$ 9,210.00**	Alt OSAGP2: Years 2 through 30
		$ 9,210.00	Alt OSAGP3: Years 2 through 11
		$ 9,210.00	Alt OSAGP4: Years 2 through 10
$ 9,210.00	x 4 quarters =	**$ 36,840.00**	Year 1

Brayack, David

From: Stavros.Patselas@tteci.com
Sent: Monday, October 03, 2005 4:27 PM
To: BrayackD@ttnus.com
Subject: Fw: Bethpage NY budgetary pricing

FORWARDED BELOW IS THE PRICING FROM A WASTE BROKER THAT TTEC PREDOMINANTLY USES IN THE NORTHEAST

Sorry, for the delay in getting you budgetary pricing for this project, but below you will find the breakdown per waste stream:

Non-hazardous soil w/PCB's < 50 ppm (Non-TSCA)
- Disposal @ $87.50/ton
- Transportation @ $1,500.00/roll-off

(pricing is based on disposal @ WM - GROWS landfill)

RCRA/TSCA soil (cadmium/chromium & PCB's > 50 ppm)
- Disposal @ $310.00/ton
- Transportation @ $2,225.00/roll-off
- NY state tax @ $54.00/ton (if applicable)

(pricing is based on disposal @ CWM - Model City)

RCRA/Non-TSCA soil (cadmium/chromium & PCB's <50 ppm)
- Disposal @ $235.00/ton
- Transportation @ $2,225.00/roll-off
- NY state tax @ $32.00/ton (if applicable)

(pricing is based on disposal @ CWM - Model City)

Roll-off Container Charges
- Roll-off mobilization @ $625.00/roll-off
- Roll-off rental @ $20.00/day
- Roll-off liner @ $45.00/ea

These prices are based on the current diesel fuel pricing and are subject to change due to changes in the cost national average cost of diesel fuel.

Please let me know if you would be needing any additional pricing or information in regards to this project.

C-8

C.2 - THERMAL TREATMENT

Purpose

NJB called vendors and regulators to determine cost and applicability of on- and off-site thermal desorption. Est 5,000 cy soil contaminated with jet fuel and chlorinated solvents (Site 6A), plus 500 cy soil contaminated with 8,100 mg/kg DRO (jet fuel) (Site 10B)

TPST Soil Recyclers of New York

TPST has a thermal treatment facility in New Windsor (upstate) New York. http://www.deep-green.com/UK/Locations/newyork.htm I emailed analytical data to Anastasia Ward [(800) 799-8778] at anastasiatps@aol.com. I was interested in on-site treatment, but she thought it would be easier to bring the contaminated soil in from Long Island if only 5000 cy. She will try to get me both on-site and off-site treatment costs, including transportation. Aly (pronounced Ollie) Bedetti called back on Oct 11. He said TPST takes non-haz only, can't take solvents.

ESMI of New York

ESMI has a thermal treatment facility in Fort Edward (upstate) New York. http://www.esmiofny.com/ Contacted Pete Hanson, ESMI Compliance Manager, at 1-800-511-3764. He said they can take jet fuel but chlorinated solvents are different. Can't take if hazardous, need NYSDEC to sign off that it is non-haz. They follow TAGM 3028 "Contained In" document for action levels for groundwater, soil, and sediment. Pete said we would need 40,000 to 50,000 tons to make on-site thermal treatment cost effective. He said I should call Todd Calder 1-860-649-3344 or cell 860-803-1000.

I called Todd Calder and emailed him data on 9/30/05. Todd called me on 10/4/05 and said his people looked at the data, would need approval of Henry Wilke at the state, if approved he could treat for $34 per ton for Site 10B soil and $47 per ton for Site 6A soil. I asked him for a transportation cost, he estimated $32 per ton. I asked about on-site treatment, Todd said we would need 50,000 tons to make on-site treatment cost effective, then may not get a DEC permit. I called Todd back on 10/5/05, he said they could do only non-haz portion of soil, I need to add 7 ¼% local sales tax. (Call to Waste Management said tax based on generator county - Suffolk county tax is 8.75%)

Site 6A non-haz soil T&D: $47/ton x 1.0875 + $32/ton = $83.11/ton
Site 10B non-haz soil T&D: $34/ton x 1.0875 + $32/ton = $68.98/to

Maxymillian Technologies

Anthony Pisanelli, apisanelli@maxymillian.com Vice President of MT gave me a budgetary quote of $485,000 for mob/demob/set-up, etc. plus $90 to $120 per ton to treat using the Indirect Thermal Desorption System (IDS). MT has done three thermal jobs in New York and one other job (slurry wall and cap) on Long Island. Treatment rate would be 350 to 400 tons per day. He asked about clean-up levels, said his estimated cost assumes unrestricted use with levels similar to Massachusetts. He said if the moisture content is above say 18%, there is a surcharge because of the need to use more fuel. He said his preference would be to also do excavation and soil preparation because they know how they want the soil (decant free product). They could also treat the decanted water. He said additional $30 to $40 for them to excavate, dewater soil, etc. He said the unit is on five tractor trailers, takes a week to set up, then runs 5 to 6 days per week, 24 hours per day.

MT also has a low temperature thermal system for just petroleum soil – RE-SOIL, lower unit cost but must bring it to their plant to treat; "fixed-base system". Very high through put. To mob, need 33 tractor trailers.

Note: Previous calls to Maxymillian indicated that for about the same cost their equipment can treat PCBs.

NYSDEC

Jim Harrington in Environmental Remediation said it is okay to use thermal desorption at an inactive hazardous waste site if the ROD or Corrective Action Plan says to; get a permit waiver from Part 375 of regs, same as CERCLA. ESMI does mostly petroleum waste and manufactured gas plant waste, mostly non-chlorinated because no scrubber. But if they said they can take it, they can. We will have a hard time getting thermal desorption done on site for only 5,000 cy unless exceeds LDRs (?) TAGM 3028 is the "Contained In" criteria. That means that constituents that are listed wastes are regulated as hazardous waste at any concentration, but if less than the "contained in" criteria, the contaminated soil can go to an approved Subtitle D landfill. For example TCA (CAS 71-55-6) would still be hazardous even if the concentration is low (depends on the source) but soil can go to a landfill if < 7,000 ppm. (58 ppm for TCE.) TAGM 3028 is only for contaminated soil. How does this relate to ESMI? – he said ask Henry Wilkie for correct version of TAGM 3028 and explanation.

Called Henry Wilkie, Division of Solid & Hazardous Material (518) 402-8594. He faxed me TAGM 3028. TAGM is currently being revised. The new TAGM will be available on the web - it will then be called TAGM BSHM-HW-92-10. The table in the new TAGM will be the same as the old one, but the rest will be shorter and address commonly asked questions. He said TAGM 3028 applies to F, K, P, and U wastes. The TAGM does not list cleanup levels, it lists the acceptable levels of wastes for thermal desorption at ESMI, etc. and Subtitle D landfills (known in NY as 360 landfills).

He said for example if a site has an average chlorinated VOC concentration of 300 mg/kg and the TAGM is 20 mg/kg, we can treat on site by thermal desorption to bring the level to 10 ppm. It will still be a listed hazardous waste, but we can now apply the "Contained In" (TAGM 3028) guidance and send it to ESMI. He said another option for pretreatment before sending to off-site thermal desorption is AS/SVE.

Conclusion:

ESMI and TPST thermal desorption units are not cost effective on site for less than 50,000 cy of soil. Fixed base units in New York state (TPST and ESMI) can only take non-hazardous soil. If the soil is non-hazardous, ESMI can treat and dispose of it for $83/ton (Site 6A) and $69/ton (Site 10B) (cost includes hauling). Hazardous determination follows TAGM 3028 (soon to be TAGM BSHM-HW-92-10). NYSDEC contact is Henry Wilkie. Maxymillian Technologies (MT) can treat Site 6A and Site 10B soils using the Indirect Thermal Desorption System (IDS) on site for $485,000 mob/demob/set-up plus $90 to $120 per ton to treat. MT has done some work on Long Island. IDS is effective on PCBs.

C.3 - IN-SITU CHEMICAL OXIDATION

Alternative S7: In-Situ Treatement of Petroleum- and Solvent-Contaminated Soil at Sites 6A and 10B by ISCO and Excavation of PCB-Contaminated Hot Spots at Site 6A and Off-Site Treatment and Disposal
Summary of ISCO (RegenOx) Requirements
Calverton, NY

Table 1 – Oxidant Costs

Application Number	RegenOx Oxidant (lbs)	RegenOx Activator (lbs)	Total RegenOx Material Required (lbs)	Total RegenOx Material Cost Per Application
1	2,369,910	2,369,910	4,739,820	$7,583,712
2	965,100	965,100	1,930,200	$3,088,320
3	396,330	396,330	792,660	$1,268,256
Total	3,731,340	3,731,340	7,462,680	$11,940,288
			Tax and Shipping (15%)	$13,731,331

Table 2 – Amount of Contaminant Mass Treated

Application Number	Estimated Mass of Contaminant Destroyed in Dissolved Phase (lbs)	Estimated Mass of Contaminant Destroyed in Sorbed Phase (lbs)	Total Mass of Contaminant Destroyed (lbs)	Cumulative Amount of RegenOx Material Applied (lbs)
1	16,056	27,261	43,317	4,739,820
2	6,423	10,904	17,327	6,670,040
3	2,740	4,362	7,102	7,462,700
Total	25,219	42,527	67,746	7,462,700

RegenOx Design Software for Grid Applications

September 2005

Regenesis Technical Support: USA (949) 366-8000 www.regenesis.com

Site Name: Long Island Site
Location: Long Island, NY
Consultant: Tetra Tech NUS - NB

Number of RegenOx application (first, second, third, fourth . . .)	first			
Is NAPL present? (yes or no)	no			
Estimated Plume Requiring Treatment				
Width of plume (intersecting gw flow direction)	500	ft		
Length of plume (parallel to gw flow direction)	200	ft	100,000	ft^2
Depth to contaminated zone	5	ft		
Thickness of contaminated saturated zone	13	ft		
Nominal aquifer soil (gravel, sand, silty sand, silt, clay)	sand			
Total porosity	0.33	Effective porosity	0.25	
Hydraulic conductivity	25	ft/day	8.8E-03	cm/sec
Hydraulic gradient	0.005	ft/ft		
Seepage velocity	182.5	ft/yr	0.500	ft/day
Treatment Zone Pore Volume	429,000	ft^3	3,209,349	gallons

Dissolved Phase Oxygen Demand: Individual species that represent oxygen demand:	Contaminant Conc (mg/L)	Contaminant Mass (lb)	Stoichiometry (wt/wt) Oxidant/contaminant	RegenOx Oxidant Dose (lb)
Benzene	100.00	2,676.1	20.1	69925
Toluene	100.00	2,676.1	20.4	70969
Ethylbenzene	100.00	2,676.1	20.7	72013
Xylenes	100.00	2,676.1	20.7	72013
Tetrachloroethene (PCE)	100.00	2,676.1	1.3	4523
Trichloroethene (TCE)	100.00	2,676.1	2.4	8349
cis-1,2-dichloroethene (DCE)	100.00	2,676.1	4.3	14959
Vinyl Chloride (VC)	100.00	2,676.1	8.4	29222
User added, add stoich. demand and Koc (see pull-down)	100.00	2,676.1	5.3	18438
User added, add stoich. demand and Koc (see pull-down)	100.00	2,676.1	2.2	7654

acetone <- pull-down menu

Measures of total oxygen demand

Estimated total oxidant demand	1.20	lbs oxid/1000 lbs soil	Total oxidant demand =	171,400	lbs
Known total oxidant demand (from bench test)	0.00	lbs oxidant/lb soil	Total oxidant demand =	0	lbs

Parameters for Sorbed Phase Oxygen Demand:

Soil bulk density	1.76	g/cm^3 =	110	lb/cf
Fraction of organic carbon (foc)	0.002	range: 0.0001 to 0.01		

(Estimated using sorbed phase = foc*Koc*Cgw)

(Adjust Koc as necessary to provide realistic estimates) Individual species that represent oxygen demand:	Koc (L/kg)	Contaminant Conc (mg/kg)	Contaminant Mass (lb)	Stoichiometry (wt/wt) Oxidant/contaminant	RegenOx Oxidant Dose (lb)
Benzene	123	24.60	3,513.7	20.1	91813
Toluene	267	53.40	7,627.3	20.4	202275
Ethylbenzene	327	65.40	9,341.3	20.7	251374
Xylenes	298	59.60	8,512.8	20.7	229081
Tetrachloroethene (PCE)	371	74.20	10,598.2	1.3	17911
Trichloroethene (TCE)	122	24.40	3,485.1	2.4	10874
cis-1,2-dichloroethene (DCE)	80	16.00	2,285.3	4.3	12775
Vinyl Chloride (VC)	2.5	0.50	71.4	8.4	780
User added, add stoich. demand and Koc (see pull-down)	0	0.00	0.0	5.3	0
User added, add stoich. demand and Koc (see pull-down)	0	0.00	0.0	2.2	0

Summary of Estimated RegenOx Requirements		Dissolved Phase Oxidant Demand (lbs)	Sorbed Phase Oxidant Demand (lbs)	Additional RegenOx Safety Factor	Total RegenOx Oxidant Demand (lbs)	RegenOx Oxidant Cost
Stoichiometric Oxidant Demand	E	368,064	816,882	2.0	2,369,893	$3,791,828 <-
Estimated Total Oxidant Demand					171,400	$274,239
Known Total Oxidant Demand					0	$0
Oxidant material requirement			Percentage of TOD accounted for	10%	2387033	$3,819,252

Required RegenOx oxidant quantity (in 30 lb increments) ——> 2,369,910 **lbs RegenOx oxidant**

Delivery Design for RegenOx

Spacing within rows (ft)	10.0	feet
# points per row	50	points/row
Spacing between rows (ft	10.0	ft
# of rows	20	rows
Advective travel time bet. rows (days)	20	days
Number of points in grid	1000	points
Oxidant application rate	182.3	lbs/foot
Total RegenOx oxidant required	2,369,910	lbs of RegenOx oxidant
Total RegenOx activator required	2,369,910	lbs of RegenOx activator

Mixing Volume for Injections

Volume of pore space	429000	ft
Percent of pore space occupied by RegenOx solution	20%	
Amount of RegenOx activator required for injection	2,369,910	lbs
Amount of water required for injection	435,705	gallons
Percent oxidant in solution	39.47%	Solids cont
Volume of water required per foot of injection	33.5	gallons
Amount of oxidant required per foot of injection	182.3	lbs
Amount of activator required per foot of injection	182.3	lbs
Total volume of solution injected per foot of injection	70.1	gallons
Radius of influence (based on injection point spacing)	0.8	feet
Estimated efficiency factor	0.60	
grams of oxidant per kg of soil	16.59	g/kg
oxidant concentration	88490	mg/L

Project Summary

Number of RegenOx delivery points (adjust as necessary for site)		1000	
RegenOx oxidant application rate in lbs/ft (adjust as necessary for site)		182.3	lbs/foot
RegenOx oxidant material requirement (lbs)		2,369,910	lbs
Number of 30 lb RegenOx oxidant buckets		78997.0	buckets
RegenOx activator application rate in lbs/ft (adjust as necessary for site)		182.3	lbs/foot
RegenOx activator material requirement		2,369,910	lbs
Number of 30 lb RegenOx activator buckets		78,997.0	buckets
Bulk RegenOx material requirement for single injection		4,739,820	lbs
Unit cost of RegenOx (per pound)	$	1.60	adjust price for > 100,000 lbs
Total RegenOx material cost for single injection	$	7,583,712	
Shipping and Tax Estimates			
Sales Tax rate: 0.00%	$	-	
Total Material Cost	$	7,583,712	
Shipping (call for amount)	$	-	
Total Regenesis Material Cost	$	7,583,712	

RegenOx Injection Cost Estimate (responsibility of customer to contract work)

Footage for each point = uncontaminated interval + RegenOx injection interval (ft)		18
Total length for direct push for project (ft)		18,000
Estimated daily installation rate (ft per day: 200 for push, 100 for drilling)		200
Estimated points per day (7 to 20 is typical for direct push)		11.1
Required number of days		90
Mob/demob cost for injection subcontractor	$	2,000
Daily rate for injection subcontractor	$	1,500
Total injection subcontractor cost for application	$	137,000
Total Install Cost (not including consultant, lab, etc.)	$	7,720,712

Other Project Cost Estimates

Design	$	-
Permitting and reporting	$	-
Construction management	$	-
Groundwater monitoring and rpts	$	-
Other	$	-
Other	$	-
Other	$	-
Other	$	-
Total Project Cost	$	7,720,712

RegenOx Design Software for Grid Applications

September 2005

Regenesis Technical Support: USA (949) 366-8000 www.regenesis.com

Site Name: Long Island Site
Location: Long Island, NY
Consultant: Tetra Tech NUS - NB

Number of RegenOx application (first, second, third, fourth ....)	second			
Is NAPL present? (yes or no)	no			
Estimated Plume Requiring Treatment				
Width of plume (intersecting gw flow direction)	500	ft		
Length of plume (parallel to gw flow direction)	200	ft	100,000	ft^2
Depth to contaminated zone	5	ft		
Thickness of contaminated saturated zone	13	ft		
Nominal aquifer soil (gravel, sand, silty sand, silt, clay)	sand			
Total porosity	0.33	Effective porosity:	0.25	
Hydraulic conductivity	25	ft/day	8.8E-03	cm/sec
Hydraulic gradient	0.005	ft/ft		
Seepage velocity	182.5	ft/yr	0.500	ft/day
Treatment Zone Pore Volume	429,000	ft^3	3,209,349	gallons

Dissolved Phase Oxygen Demand: Individual species that represent oxygen demand	Contaminant Conc. (mg/L)	Contaminant Mass (lb)	Stoichiometry (wt/wt) Oxidant/contaminant	RegenOx Oxidant Dose (lb)
Benzene	40.00	1,070.4	20.1	27970
Toluene	40.00	1,070.4	20.4	28388
Ethylbenzene	40.00	1,070.4	20.7	28805
Xylenes	40.00	1,070.4	20.7	28805
Tetrachloroethene (PCE)	40.00	1,070.4	1.3	1809
Trichloroethene (TCE)	40.00	1,070.4	2.4	3340
cis-1,2-dichloroethene (DCE)	40.00	1,070.4	4.3	5984
Vinyl Chloride (VC)	40.00	1,070.4	8.4	11689
User added, add stoich. demand and Koc (see pull-down)	40.00	1,070.4	5.3	7375
User added, add stoich. demand and Koc (see pull-down)	40.00	1,070.4	2.2	3061

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Measures of total oxygen demand					
Estimated total oxidant demand	1.20	lbs oxid/1000 lbs soil	Total oxidant demand =	171,400	lbs
Known total oxidant demand (from bench test)	0.00	lbs oxidant/lb soil	Total oxidant demand =	0	lbs

Parameters for Sorbed Phase Oxygen Demand:

Soil bulk density	1.76	g/cm^3 =	110	lb/cf
Fraction of organic carbon (foc)	0.002	range: 0.0001 to 0.01		

(Estimated using sorbed phase = foc*Koc*Cgw)

(Adjust Koc as necessary to provide realistic estimates) Individual species that represent oxygen demand	Koc (L/kg)	Contaminant Conc. (mg/kg)	Contaminant Mass (lb)	Stoichiometry (wt/wt) Oxidant/contaminant	RegenOx Oxidant Dose (lb)
Benzene	123	9.84	1,405.5	20.1	36725
Toluene	267	21.36	3,050.9	20.4	80910
Ethylbenzene	327	26.16	3,736.5	20.7	100550
Xylenes	298	23.84	3,405.1	20.7	91632
Tetrachloroethene (PCE)	371	29.68	4,239.3	1.3	7164
Trichloroethene (TCE)	122	9.76	1,394.0	2.4	4349
cis-1,2-dichloroethene (DCE)	80	6.40	914.1	4.3	5110
Vinyl Chloride (VC)	2.5	0.20	28.6	8.4	312
User added, add stoich. demand and Koc (see pull-down)	0	0.00	0.0	5.3	0
User added, add stoich. demand and Koc (see pull-down)	0	0.00	0.0	2.2	0

Summary of Estimated RegenOx Requirements	Dissolved Phase Oxidant Demand (lbs)	Sorbed Phase Oxidant Demand (lbs)	Additional RegenOx Safety Factor	Total RegenOx Oxidant Demand (lbs)	RegenOx Oxidant Cost
Stoichiometric Oxidant Demand	147,226	326,753	2.0	947,957	$1,516,731
Estimated Total Oxidant Demand				171,400	$274,239
Known Total Oxidant Demand				0	$0
Oxidant material requirement		Percentage of TOD accounted for:	10%	965097	$1,544,155 <-

Required RegenOx oxidant quantity (in 30 lb increments) ——————> 965,100 **lbs RegenOx oxidant**

Delivery Design for RegenOx		
Spacing within rows (ft)	10.0	feet
# points per row	50	points/row
Spacing between rows (ft	10.0	ft
# of rows	20	rows
Advective travel time bet. rows (days)	20	days
Number of points in grid	1000	points
Oxidant application rate	74.2	lbs/foot
Total RegenOx oxidant required	965,100	lbs of RegenOx oxidant
Total RegenOx activator required	965,100	lbs of RegenOx activator

Mixing Volume for Injections		
Volume of pore space	429000	ft^3
Percent of pore space occupied by RegenOx solution	20%	
Amount of RegenOx activator required for injection	965,100	lbs
Amount of water required for injection	557,862	gallons
Percent oxidant in solution	17.18%	Solids con
Volume of water required per foot of injection	42.9	gallons
Amount of oxidant required per foot of injection	74.2	lbs
Amount of activator required per foot of injection	74.2	lbs
Total volume of solution injected per foot of injection	57.8	gallons
Radius of influence (based on injection point spacing)	0.8	feet
Estimated efficiency factor	0.60	
grams of oxidant per kg of soil	6.76	g/kg
oxidant concentration	36036	mg/L

Project Summary			
Number of RegenOx delivery points (adjust as necessary for site)		1000	
RegenOx oxidant application rate in lbs/ft (adjust as necessary for site)		74.2	lbs/foot
RegenOx oxidant material requirement (lbs)		965,100	lbs
Number of 30 lb RegenOx oxidant buckets		32170.0	buckets
RegenOx activator application rate in lbs/ft (adjust as necessary for site)		74.2	lbs/foot
RegenOx activator material requirement		965,100	lbs
Number of 30 lb RegenOx activator buckets		32,170.0	buckets
Bulk RegenOx material requirement for single injection		1,930,200	lbs
Unit cost of RegenOx (per pound)	$	1.60	adjust price for >100,000 lbs
Total RegenOx material cost for single injection	$	3,088,320	
Shipping and Tax Estimates			
Sales Tax rate: 0.00%	$	-	
Total Material Cost	$	3,088,320	
Shipping (call for amount)	$	-	
Total Regenesis Material Cost	$	3,088,320	

RegenOx Injection Cost Estimate (responsibility of customer to contract work)		
Footage for each point = uncontaminated interval + RegenOx injection interval (ft)		18
Total length for direct push for project (ft)		18,000
Estimated daily installation rate (ft per day; 200 for push, 100 for drilling)		200
Estimated points per day (7 to 20 is typical for direct push)		11.1
Required number of days		90
Mob/demob cost for injection subcontractor	$	2,000
Daily rate for injection subcontractor	$	1,500
Total injection subcontrator cost for application	$	137,000
Total Install Cost (not including consultant, lab, etc.)	$	3,225,320

Other Project Cost Estimates		
Design	$	-
Permitting and reporting	$	-
Construction management	$	-
Groundwater monitoring and rpts	$	-
Other	$	-
Other	$	-
Other	$	-
Other	$	-
Total Project Cost	$	3,225,320

RegenOx Design Software for Grid Applications

September 2005

Regenesis Technical Support: USA (949) 366-8000 www.regenesis.com

Site Name: Long Island Site
Location: Long Island, NY
Consultant: Tetra Tech NUS - NB

Number of RegenOx application (first, second, third, fourth . . .)	third			
Is NAPL present? (yes or no)	no			
Estimated Plume Requiring Treatment				
Width of plume (intersecting gw flow direction)	500	ft		
Length of plume (parallel to gw flow direction)	200	ft	100,000	ft^2
Depth to contaminated zone	5	ft		
Thickness of contaminated saturated zone	13	ft		
Nominal aquifer soil (gravel, sand, silty sand, silt, clay)	sand			
Total porosity	0.33	Effective porosity:	0.25	
Hydraulic conductivity	25	ft/day	8.8E-03	cm/sec
Hydraulic gradient	0.005	ft/ft		
Seepage velocity	182.5	ft/yr	0.500	ft/day
Treatment Zone Pore Volume	429,000	ft^3	3,209,349	gallons

Dissolved Phase Oxygen Demand:

Individual species that represent oxygen demand:	Contaminant Conc. (mg/L)	Contaminant Mass (lb)	Stoichiometry (wt/wt) Oxidant/contaminant	RegenOx Oxidant Dose (lb)
Benzene	16.00	428.2	20.1	11188
Toluene	16.00	428.2	20.4	11355
Ethylbenzene	16.00	428.2	20.7	11522
Xylenes	16.00	428.2	20.7	11522
Tetrachloroethene (PCE)	16.00	428.2	1.3	724
Trichloroethene (TCE)	16.00	428.2	2.4	1336
cis-1,2-dichloroethene (DCE)	16.00	428.2	4.3	2393
Vinyl Chloride (VC)	16.00	428.2	8.4	4676
User added, add stoich. demand and Koc (see pull-down)	16.00	428.2	5.3	2950
User added, add stoich. demand and Koc (see pull-down)	16.00	428.2	2.2	1225

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Measures of total oxygen demand

Estimated total oxidant demand	1.20	lbs oxid/1000 lbs soil	total oxidant demand =	171,400	lbs
Known total oxidant demand (from bench test)	0.00	lbs oxidant/lb soil	total oxidant demand =	0	lbs

Parameters for Sorbed Phase Oxygen Demand:

Soil bulk density	1.76	g/cm^3 =	110	lb/cf
Fraction of organic carbon (foc)	0.002	range: 0.0001 to 0.01		

(Estimated using sorbed phase = foc*Koc*Cgw)
(Adjust Koc as necessary to provide realistic estimates)

Individual species that represent oxygen demand:	Koc (L/kg)	Contaminant Conc. (mg/kg)	Contaminant Mass (lb)	Stoichiometry (wt/wt) Oxidant/contaminant	RegenOx Oxidant Dose (lb)
Benzene	123	3.94	582.2	20.1	14690
Toluene	267	8.54	1,220.4	20.4	32364
Ethylbenzene	327	10.46	1,494.6	20.7	40220
Xylenes	298	9.54	1,362.1	20.7	36653
Tetrachloroethene (PCE)	371	11.87	1,695.7	1.3	2866
Trichloroethene (TCE)	122	3.90	557.6	2.4	1740
cis-1,2-dichloroethene (DCE)	80	2.56	365.7	4.3	2044
Vinyl Chloride (VC)	2.5	0.08	11.4	8.4	125
User added, add stoich. demand and Koc (see pull-down)	0	0.00	0.0	5.3	0
User added, add stoich. demand and Koc (see pull-down)	0	0.00	0.0	2.2	0

Summary of Estimated RegenOx Requirements	Dissolved Phase Oxidant Demand (lbs)	Sorbed Phase Oxidant Demand (lbs)	Additional RegenOx Safety Factor	Total RegenOx Oxidant Demand (lbs)	RegenOx Oxidant Cost
Stoichiometric Oxidant Demand	58,890	130,701	2.0	379,183	$606,693
Estimated Total Oxidant Demand				171,400	$274,239
Known Total Oxidant Demand				0	$0
Oxidant material requirement		Percentage of TOD accounted for	10%	396323	$634,116 <-

Required RegenOx oxidant quantity (in 30 lb increments) ---> 396,330 **lbs RegenOx oxidant**

Delivery Design for RegenOx

Spacing within rows (ft)	12.0	feet
# points per row	42	points/row
Spacing between rows (ft	12.0	ft
# of rows	17	rows
Advective travel time bet. rows (days)	24	days
Number of points in grid	714	points
Oxidant application rate	42.7	lbs/foot
Total RegenOx oxidant required	396,330	lbs of RegenOx oxidant
Total RegenOx activator required	198,165	lbs of RegenOx activator

Mixing Volume for Injections

Volume of pore space	429000	ft^3
Percent of pore space occupied by RegenOx solution	20%	
Amount of RegenOx activator required for injection	396,330	lbs
Amount of water required for injection	607,321	gallons
Percent oxidant in solution	7.28%	Solids cont
Volume of water required per foot of injection	65.4	gallons
Amount of oxidant required per foot of injection	42.7	lbs
Amount of activator required per foot of injection	42.7	lbs
Total volume of solution injected per foot of injection	74.0	gallons
Radius of influence (based on injection point spacing)	0.9	feet
Estimated efficiency factor	0.60	
grams of oxidant per kg of soil	2.77	g/kg
oxidant concentration	14799	mg/L

Project Summary			
Number of RegenOx delivery points (adjust as necessary for site)		714	
RegenOx oxidant application rate in lbs/ft (adjust as necessary for site)		42.7	lbs/foot
RegenOx oxidant material requirement (lbs)		396,330	lbs
Number of 30 lb RegenOx oxidant buckets		13211.0	buckets
RegenOx activator application rate in lbs/ft (adjust as necessary for site)		42.7	lbs/foot
RegenOx activator material requirement		396,330	lbs
Number of 30 lb RegenOx activator buckets		13,211.0	buckets
Bulk RegenOx material requirement for single injection		792,660	lbs
Unit cost of RegenOx (per pound)	$	1.60	adjust price for > 100,000 lbs
Total RegenOx material cost for single injection	$	1,268,256	
Shipping and Tax Estimates			
Sales Tax rate: 0.00%	$	-	
Total Material Cost	$	1,268,256	
Shipping (call for amount)	$	-	
Total Regenesis Material Cost	$	1,268,256	

RegenOx Injection Cost Estimate (responsibility of customer to contract work)		
Footage for each point = uncontaminated interval + RegenOx injection interval (ft)		18
Total length for direct push for project (ft)		12,852
Estimated daily installation rate (ft per day: 200 for push, 100 for drilling)		200
Estimated points per day (7 to 20 is typical for direct push)		11.1
Required number of days		65
Mob/demob cost for injection subcontractor	$	2,000
Daily rate for injection subcontractor	$	1,500
Total injection subcontractor cost for application	$	99,500
Total Install Cost (not including consultant, lab, etc.)	$	1,367,756

Other Project Cost Estimates		
Design	$	-
Permitting and reporting	$	-
Construction management	$	-
Groundwater monitoring and rpts	$	-
Other	$	-
Other	$	-
Other	$	-
Other	$	-
Total Project Cost	$	1,367,756

C-14

C.4 - AIR SPARGING/SOIL VAPOR EXTRACTION

1.0 TREATMENT SCHEME

The option of Alternative S5 & SAGW4 would consist of an air sparging (AS) and soil vapor extraction (SVE) system. The AS system would feature the following elements:

- AS well array
- AS blower system

The SVE system would feature the following elements:

- SVE well array
- Vapor extraction pump system
- Vapor-phase granular activated carbon (GAC) adsorption system.

Typical remedial action duration for AS/SVE systems ranges from one to five years. For the purpose of this FS, it is assumed that remedial action duration would be 2 to 4 years.

2.0 AS WELL ARRAY

Based upon previous calculations for Site 7 (Fuel Depot Area) at Calverton, the typical radius of influence (ROI) of AS wells is approximately 25 ft.

Area of influence per AS well: $(50)^2 \times \pi/4 = 1{,}963\ ft^2$, rounded down to $1{,}950\ ft^2$ for overlap

AS wells will be installed at one depth, screened from 15 to 20 feet below the water table (water table approximately 7 ft bgs - total depth of the wells will be approximately 30 feet below ground surface) in the area of the plume.

Number of wells in the AS Well Array: (Area of Plume in ft^2) $\div$ Area of influence ft^2 = number of wells

For Site 6A: $(99{,}700\ ft^2) \div 1950\ ft^2$ = approximately 51 wells

For Site 10B: $(25{,}200\ ft^2) \div 1950\ ft^2$ = approximately 13 wells

See the attached Figure B-1 for the AS Well Array Layout. The number of wells on the figure/layout is approximately the same as the number calculated.

3.0 AS BLOWER SYSTEMS

The typical air sparging flow is approximately 6 to 12 cfm per well.

For the AS System, an individual AS Blower System would supply air to each site of the AS Well Array installed at a given depth. AS Blower System would feature 1 blower for each site. The blower would provide air to the wells at each site

For Site 6A:

Discharge rate of AS Blower: 51 wells x 6 cfm/well = 306, say 300 cfm

Discharge rate of AS Blower: 51 wells x 12 cfm/well = 612, say 600 cfm

Static head required for the AS Blower: 20 ft H_2O x 0.433 ft/psi = 8.7 psi

To accommodate line friction losses, increase the design blower discharge pressure 15%. The AS Blower would be designed for a discharge head of 10 psi.

⇒ AS Blower System would feature 1 blower. The AS Blower would be rated for 600 cfm @ 17 psi.

For Site 10B:
Discharge rate of AS Blower: 13 wells x 6 cfm/well = 78, say 80 cfm
Discharge rate of AS Blower: 12 wells x 12 cfm/well = 156, say 160 cfm

Static head required for the AS Blower: 20 ft H_2O x 0.433 ft/psi = 8.7 psi

To accommodate line friction losses, increase the design blower discharge pressure 15%. The AS Blower would be designed for a discharge head of 10 psi.

⇒ AS Blower System would feature 1 blower. The AS Blower would be rated for 160 cfm @ 17 psi.

4.0 FUGITIVE EMISSIONS

As per computations presented in Appendix A (Mass & Volume Calculations), the total quantities of VOC COCs for the site are estimated as follows:

	Site 6A		Site 10B	
Soil				
cVOC	210	pounds	0	pounds
BTEX	160	pounds	0	pounds
Petroleum	74480	pounds	21,400	pounds
PAHs	170	pounds	0	pounds
PCBs	210	pounds	0	pounds
Groundwater				
VOC	1	pounds	1	pounds
BTEX	1	pounds	0	pounds
cVOC	3	pounds	0	pounds
TOTAL	**75,025**	**pounds**	**21,401**	**pounds**

Of these, it is assumed that 100% of the BTEX, cVOCs, and VOCs in groundwater and 50% of the VOC, BTEX, PAHs, and cVOCs in soil will eventually be removed by stripping and generate fugitive emissions:

Total Fugitive Emissions for Site 6A
5 + (0.5 x 75,020) = 37,515 pounds

It is assumed that 75% of these emissions will occur during the first year of operation of the AS treatment systems and that, within, that first year, half of the emissions would occur during the first 30 days:

Maximum Daily Rate of Fugitive Emissions:
37,515 pounds x 0.75 x 0.5 ÷ 30 = 469 pounds per day

Based on the calculated fugitive emission, the AS system would need to be operated with fugitive emissions controls.

Total Fugitive Emissions for Site 10B
1 + (0.5 x 21,400) = 10,701 pounds

It is assumed that 75% of these emissions will occur during the first year of operation of the AS treatment systems and that, within, that first year, half of the emissions would occur during the first 30 days:

Maximum Daily Rate of Fugitive Emissions:
10,701 pounds x 0.75 x 0.5 ÷ 30 = 135 pounds per day

Based on the calculated fugitive emission, the AS system would need to be operated with fugitive emissions controls.

5.0 SVE WELL OR TRENCH ARRAY

Based upon previous calculations for Site 7 (Fuel Depot Area) at Calverton and general rule of thumb, the typical radius of influence (ROI) of SVE wells is approximately half of the AS wells – this is approximately 12 ft for Sites 6A and 10B.

Area of influence per SVE well: $(24)^2 \times \pi/4 = 438$ ft^2, rounded down to 425 ft^2 for overlap

SVE wells will be installed at one depth, screened from 2 to 7 feet below the ground surface in the area of the plume.

Number of wells in the SVE Well Array: (Area of Plume in ft^2) ÷ Area of influence ft^2 = number of wells
For Site 6A: (99,700 ft^2) ÷ 425 ft^2 = approximately 235 wells
For Site 10B: (25,200 ft^2) ÷ 425 ft^2 = approximately 60 wells

As an alternative, trenches can be used to collect the vapor emissions. The SVE trench array would be installed at intervals/spacing of 30 feet for the length of the plume.
For Site 6A: 300 ft wide by 500 feet long 300 ft ÷ 30 ft spacing = 10 trenches
For Site 10B: 150 ft wide by 200 feet long 150 ft ÷ 30 ft spacing = 5 trenches

6.0 SVE EXTRACTION PUMP SYSTEMS

Based on experience with AS/SVE systems, the vapor extraction rate is designed as approximately 150% of the air sparging rate.

For the SVE System, an individual SVE extraction pump system would extract vapors from each site of the SVE Well Array installed at a given depth. SVE extraction pump system would feature 1 extraction pump for each site.

For Site 6A:
Vapor extraction rate: 600 cfm x 1.5 = 900 cfm

Check vapor extraction rate per well: 900 cfm ÷ 235 wells = 3.8 cfm/well - OK

⇒ SVE Extraction Pump System would feature pump. The SVE Extraction Pump System would be rated for 900 cfm vacuum pump (10 BHP) at 4" Hg and one 150-gallon moisture separator.

For Site 10B:
Vapor extraction rate: 160 cfm x 1.5 = 240 cfm

Check vapor extraction rate per well: 240 cfm ÷ 60 wells = 4 cfm/well - OK

⇒ SVE Extraction Pump System would feature pump. The SVE Extraction Pump System would be rated for 250 cfm vacuum pump (3 BHP) at 4" Hg and one 80-gallon moisture separator.

6.0 VAPOR PHASE GAC ADSORPTION SYSTEMS

The main VOCs in the vapor extraction system offgas will be petroleum related (BTEX) with minor offgas of cVOCs. It is assumed that approximately 10 pounds of GAC will be consumed for each pound of VOC removed.

For Site 6A:
From **4.0 FUGATIVE EMISSIONS** – it was estimated that 37,620 pounds will be generated at the site.

GAC Required: 37,515 pounds x 10 lb GAC/lb VOC = 375,150 lbs.

Recommended GAC unit capacity for a 900 cfm vapor flow rate is 13,600 pounds (see attached chart)

⇒ For Site 6A a vapor phase GAC adsorption system consisting of two (2) units operating in series and holding 13,600 lbs of GAC. System to be designed such that either unit can be placed in lead or lag position.

Estimated replacement frequency of lead GAC unit: (375,150 lbs used ÷ 13,600 lbs in lead unit) – 1 = 26.6 times
Say 27 times over 4 years (48 months) – Changes could be weekly in the beginning of operation.

For Site 10B:
From **4.0 FUGATIVE EMISSIONS** – it was estimated that 10,701 pounds will be generated at the site.

GAC Required: 10,701 pounds x 10 lb GAC/lb VOC = 107,010 lbs.

Recommended GAC unit capacity for a 240 cfm vapor flow rate is 13,600 pounds (see attached chart)

⇒ For Site 10B a vapor phase GAC adsorption system consisting of two (2) units operating in series and holding 13,600 lbs of GAC. System to be designed such that either unit can be placed in lead or lag position.

Estimated replacement frequency of lead GAC unit: (107,010 lbs used ÷ 13,600 lbs in lead unit) – 1 = 6.9 times
Say 7 times over 4 years (48 months) – Changes could be weekly in the beginning of operation.

8.0 ESTIMATE QUANTITIES

Item	Site 6A	Site 10B
AS Blower	600 cfm @ 10 psi	160 cfm @ 10 psi
AS Wells – 30 ft deep, screened 25 to 30 ft	51-55 1530 to 1650 ft	13-15 390 to 450 ft
AS Piping	3000 ft	800-900 ft
SVE Extraction Pump System	900 cfm vacuum pump (10 BHP) at 4" Hg	250 cfm vacuum pump (3 BHP) at 4" Hg
SVE Wells – 7 ft deep, screened 2 to 7 ft **or**	235 1645 ft	60 420 ft
SVE Trenches	10 trenches 500 feet long	5 trenches 200 feet long
SVE Piping	6000 ft	2000 ft
Moisture Separator	one 150-gallon	one 80-gallon
GAC System	2 units holding 13,600 lbs Approximately 27 change outs	2 units holding 13,600 lbs Approximately 7 change outs

Miscellaneous Items

Equipment control area/structure to protect the equipment from inclement weather and vandalism.
The AS/SVE equipment will be skid-mounted
Control Panel and associated Process and Instrumentation Diagram (P&ID)

Moisture Separator includes an automatic pumping (a one (1) horsepower (HP) Transfer Pump) option to discharge water to the larger Wastewater Storage Tank. A one (1) horsepower (HP) Transfer Pump will automatically or manually discharge collected to the Wastewater Storage Tank. An intrinsically safe float switch in the Moisture Separator will shut down the Vapor Extraction Blower in the case of high liquid level condition. The transfer pump will automatically turn on and drain the moisture separator until the low level float is triggered at which point the blower is shut off and the SVE system is automatically restarted. This operation can also be run manually. The larger Wastewater Storage Tank will be equipped with a high liquid level indicator that will shut the SVE system down until the tank is drained.

The SVE extraction pumps inlet will be equipped with a cartridge-type filter for protection against abrasive solid particles.

The GAC adsorber vessels will be connected with two (2) inch flexible pressure hose with quick connections so that either vessel can easily be placed in the lead or lag position.

Controls - Operation of the AS Blower and SVE extraction pump will be controlled by a HAND-OFF-AUTO switch. In the AUTO position, which is the normal mode of operation, the blower will be running continuously, but its operation will be interlocked with the High Level Switches located in the Moister Separator and Wastewater Storage Tank and a high temperature switch located in the discharge of the SVE extraction pump. If these switches are tripped, the vacuum extraction blower will shut down.

Pressure will be monitored by gauges located immediately upstream of the AS Blower, immediately upstream of the air bleed valve and at each extraction line connecting the AS Blower wells. Vacuum will be monitored by gauges located immediately upstream of the SVE extraction pump, immediately upstream of the air bleed valve and at each extraction line connecting the vapor extraction wells.

Air flow will be monitored by flow indicators. As required, air flow will be adjusted at each AS well array using the manual ball valves provided for this purpose. Extracted vapor flow will be monitored by flow indicators. As required, vapor flow will be adjusted at from each vapor extraction zone using the manual ball valves provided for this purpose.

Piping – Piping for the AS system and upstream of the vapor extraction pump will be constructed of PVC. Piping downstream of the vapor extraction blower and up to the GAC connection will be two (2) inch diameter galvanized steel to allow heat dissipation. Pipe sizing will consider the head losses in the lines due to friction. Piping located outside the Equipment Control Area will be installed below grade to protect it throughout the duration of system operation. Piping will be buried a maximum of 6 inches below grade. Cover material shall consist of select native fill and shall not contain any debris in excess of one (1) inch in diameter. Topsoil will be used on the top 3" to assure proper soil for revegetation. Flow and pressure gauges and pressure regulators will be installed within the equipment control building for each well group along the header line.

Power Source - An electrical schematic for the AS/SVE unit will be provided. Permanent power will be made available to the site (480-volt, 3-phase). All electrical components shall be installed in accordance with National Electric Codes and local requirements. All equipment shall be grounded and wired to provide surge protection.

Site 10B Site 10B

Site 6A

CARBONAIR
ENVIRONMENTAL SERVICES

2731 Nevada Avenue North
New Hope, MN 55427
612-544-2154 800-526-4999
Fax 612-544-2151

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SPECIFICATIONS

MODELS	GPC 3	GPC 3H	GPC 3.85	GPC 5R	GPC 7R	GPC 13R	GPC 20R	GPC 50R	GPC 70	GPC 120
DIMENSIONS	24½" OD (0.62 m) 36½"H (0.93 m)	24½" OD (0.62 m) 36½"H (0.93 m)	28½" OD (0.72 m) 38½"H (0.98 m)	30" OD (0.76 m) 5'8"H (1.73 m)	3' OD (0.91 m) 7'2"H (2.18 m)	4' OD (1.2 m) 7'2"H (2.18 m)	5' OD (1.5 m) 7'2"H (2.18 m)	8' OD (2.44 m) 7'2"H (2.18 m)	16'8½"L x 5'W x 7'6" H (5.0 m x 1.5 m x 2.3 m)	16'6"L x 8'W x 7'10"H (5.0 m x 2.4 m x 2.4 m)
BED AREA	2.7 sq.ft. (0.29 sq.m)	2.7 sq.ft. (0.29 sq.m)	3.68 sq.ft. (0.39 sq.m)	4.91 sq.ft. (0.53 sq.m)	7.07 sq.ft. (0.76 sq.m)	12.57 sq.ft. (1.35 sq.m)	19.63 sq.ft. (2.11 sq.m)	50.27 sq.ft. (5.41 sq.m)	69.8 sq.ft. (6.49 sq.m)	120 sq.ft. (11.15 sq.m)
FLOW RANGE	20-100 cfm (0.6-3 m^3/min)	20-270 cfm (0.6-8 m^3/min)	36-360 cfm (1-10 m^3/min)	40-380 cfm (1-10 m^3/min)	76-500 cfm (2-15 m^3/min)	120-800 cfm (3-24 m^3/min)	200-1,800 cfm (6-54 m^3/min)	480-4,000 cfm (14-120 m^3/min)	700-7,000 cfm (20-200 m^3/min)	200-12,000 cfm (34-340 m^3/min)
CARBON CAPACITY	200 lbs (68 kg)	200 lbs (68 kg)	250 lbs (114 kg)	500 lbs (228 kg)	1,000 lbs (456 kg)	1,500 lbs (681 kg)	2,000 lbs (908 kg)	5,000 lbs (2,270 kg)	10,000 lbs (4,540 kg)	13,600 lbs (6,174 kg)
FITTINGS	1½" PVC inlet and outlet ports	4" PVC inlet and outlet ports	4" PVC inlet and outlet ports	4½" nozzle (2) ½" half couplings (1) 30" access port	6 ⅝" nozzle (2) ½" half couplings (1) 24" access port	8 ⅝" nozzle (2) ½" half couplings (1) 24" access port	8 ⅝" nozzle (2) ½" half couplings (1) 24" access port	12 ¾" nozzle (2) ½" half couplings (1) 24" access port	(4) 12¾" inlet nozzles (2) 12¾" outlet nozzles 1" condensate drain (2) ¾" half coupling (2) 20" access ports	(4) 12¾" inlet nozzles (2) 12¾" outlet nozzles 1" condensate drain (2) ¾" half coupling (2) 20" access ports
EMPTY WEIGHT	65 lbs (29 kg)	65 lbs (29 kg)	100 lbs (45 kg)	375 lbs (170 kg)	700 lbs (317 kg)	950 lbs (431 kg)	1,200 lbs (544 kg)	2,900 lbs (1,315 kg)	5,500 lbs (2,495 kg)	7,500 lbs (3,402 kg)
OPERATING WEIGHT	275 lbs (125 kg)	275 lbs (125 kg)	350 lbs (159 kg)	900 lbs (408 kg)	1,800 lbs (816 kg)	2,450 lbs (1,111 kg)	3,200 lbs (1,452 kg)	8,000 lbs (3,629 kg)	16,000 lbs (7,258 kg)	22,000 lbs (9,979 kg)
INLET/OUTLET NOZZLES	1½" (3.81 cm)	4" (10.16 cm)	4" (10.16 cm)	4½" (11.43 cm)	6 ⅝" (16.83 cm)	8 ⅝" (21.9 cm)	8 ⅝" (21.9cm)	12 ¾" (32.38 cm)	12 ¾" (32.38 cm)	12 ¾" (32.38 cm)

Gas Phase Carbon Adsorbers

Carbonair's gas phase carbon adsorbers are designed to provide an efficient and economical means to control odor, toxic vapors and corrosive gases. Several types of activated carbons are available for a variety of applications.

DESIGN

GPC 3 & 3H
- UN Standard 55-gallon steel drum.
- Two 2" PVC connections. (GPC 3)
- Two 4" PVC connections. (GPC 3H)
- Baked enamel exterior.
- Epoxy-phenolic interior lining.
- Quick installation.

Carbon Cap.: GPC 3 - 200 lbs.
GPC 3H - 200 lbs.

GPC 3.85
- UN Standard 85-gallon steel drum.
- Two 4" PVC connections.
- Baked enamel exterior.
- Epoxy-phenolic interior lining.
- PVC internals.

Carbon Cap.: GPC 3.85 - 250 lbs.

GPC 5R
- Welded steel round construction.
- Two 4" NPT connections.
- One ½" drain.
- Fork tubes for easy lifting.
- Bolt down lugs.
- Polyamide epoxy/urethane interior & exterior finish.
- FRP grate with stainless steel screen.

Carbon Cap.: GPC 5R - 500 lbs.

GPC 7R
- Welded steel round construction.
- Two 6 ⅝" nozzle connections.
- FRP grate with stainless steel screen.
- Bolt down lugs.
- Polyamide epoxy/urethane interior & exterior finish.
- Fork tubes for easy lifting.

Carbon Cap.: GPC 7R - 1000 lbs.

GPC 13R & GPC 20R
- Welded steel round construction.
- Fork tubes for easy lifting.
- One condensation drain.
- FRP grate with stainless steel screen.
- Polyamide epoxy/urethane interior & exterior finish.
- Two 8 ⅝" nozzle connections.

Carbon Cap.: GPC 13R - 1,500 lbs.
GPC 20R - 2,000 lbs.

GPC 50R
- Welded steel round construction.
- Fork tubes for easy lifting.
- FRP grate with stainless steel screen.
- Two 12 ¾" nozzle connections.
- Bolt down lugs.
- Polyamide epoxy/urethane interior & exterior finish.
- Two ½" drain/sample couplings.

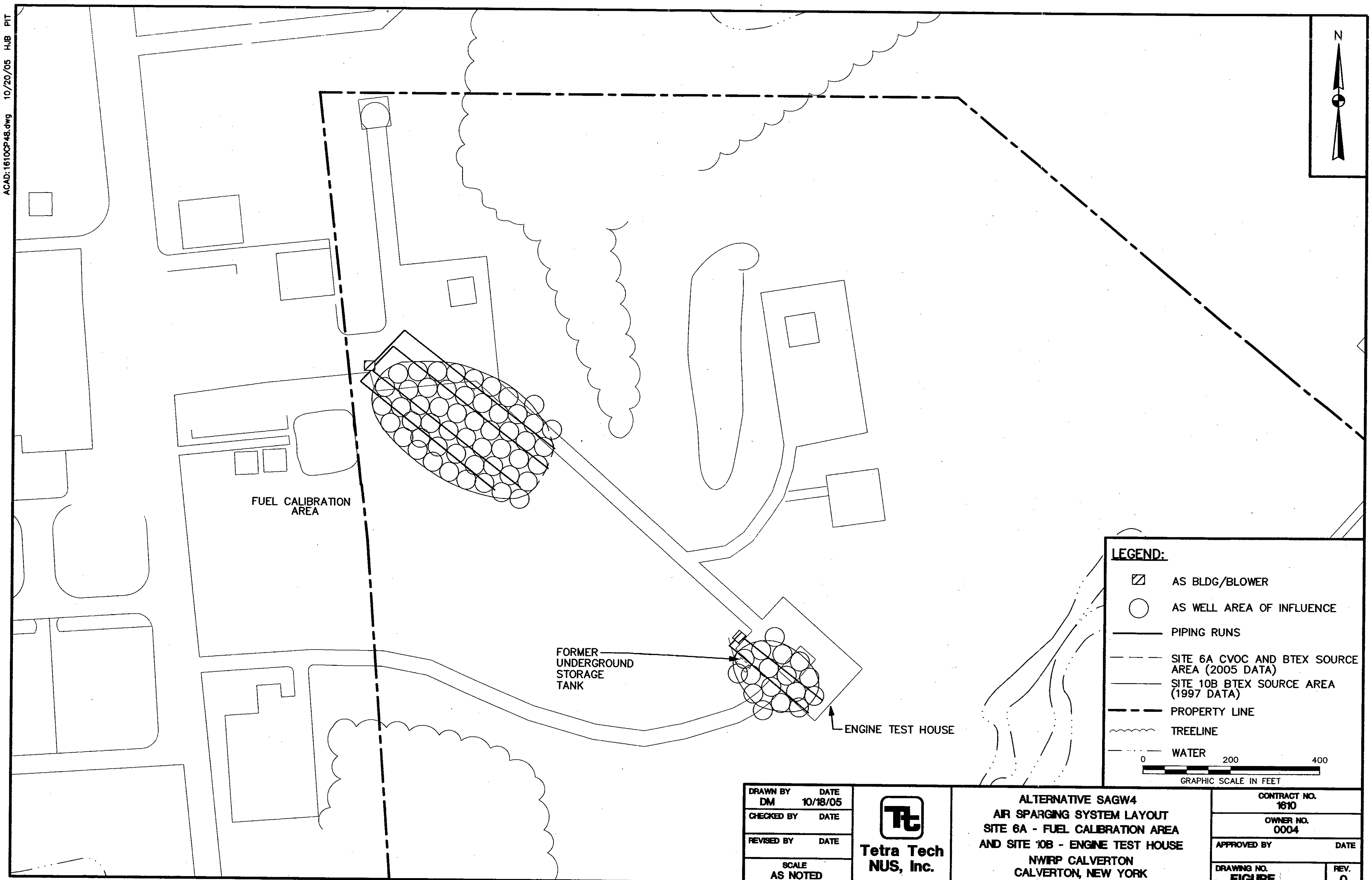
Carbon Cap.: GPC 50R - 5,000 lbs.

GPC 70 & 120
- Welded steel rectangular construction.
- Skid mounted with lifting lugs.
- Polyamide epoxy/urethane interior & exterior finish.
- FRP grate with stainless steel screen.
- Four 12¾" inlet ports.
- Two quick-disconnect off-gas ports.
- Two sample ports.
- One condensation drain.

Carbon Cap.: GPC 70 - 10,000 lbs.
GPC 120 - 13,600 lbs.

OPTIONS

Blowers   Humidity control
Influent/effluent ducting
Discharge stack   Controls
Additional sampling couplings and valves



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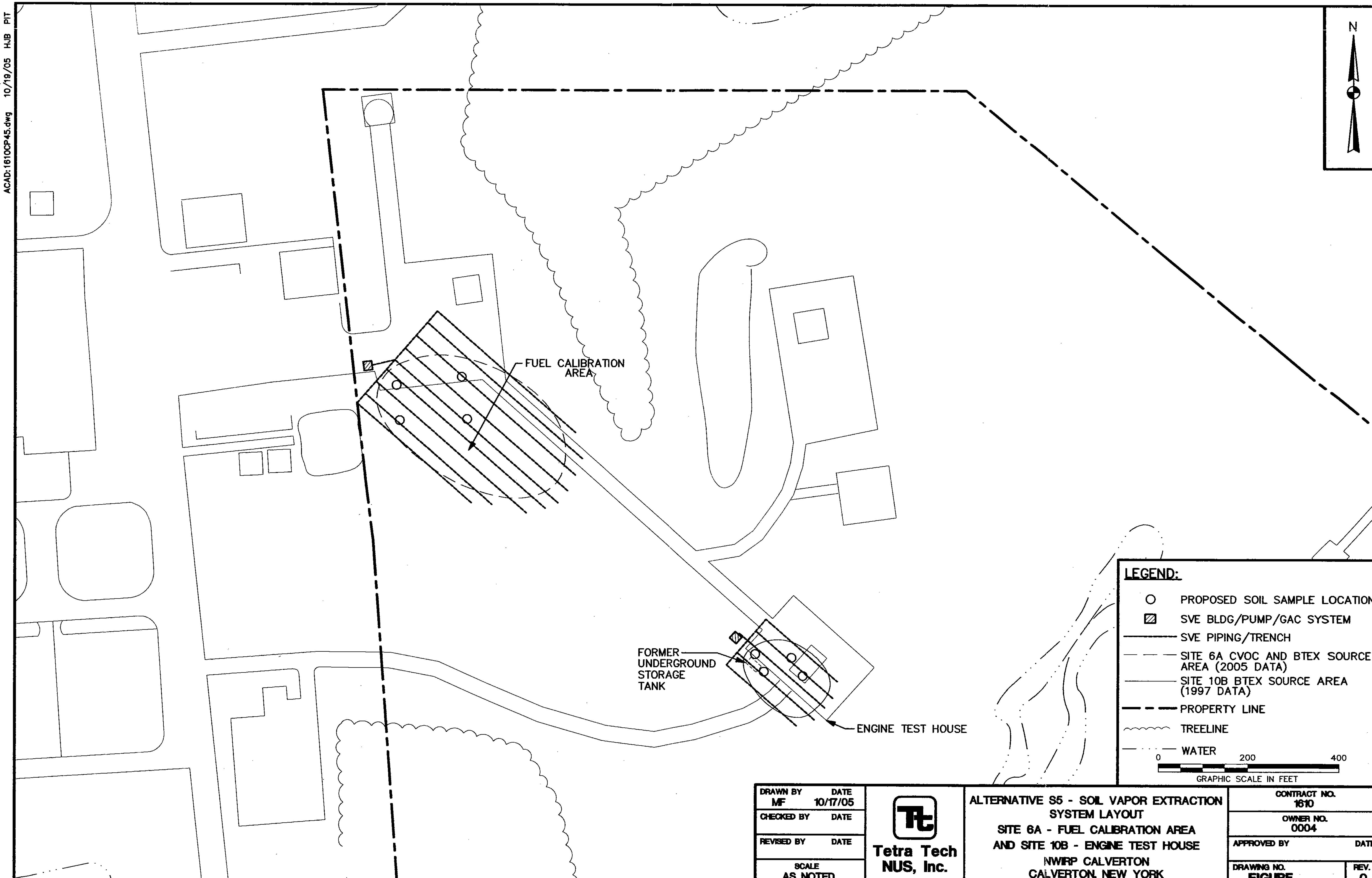


FORM CADD NO. TTNUS-BH.DWG - REV 1 - 9/10/98

C.5 - GROUNDWATER PUMP AND TREAT

C.5-1 - EXTRACTION SYSTEM

C.5-2 - TREATMENT SYSTEM

C.5-1 - EXTRACTION SYSTEM

Project:	NWIRP Calverton	**Project No.:**	1610
Subject:	FC Area (Site 6A) Groundwater Extraction System FS Designs		
By:	JPO	**Date:**	10/4/2005
Checked:		**Date:**	

Project/Design Objective:

Design a groundwater extraction system for containment/cleanup of the source area for the chlorinated VOC/BTEX plume in the shallow groundwater flow system. Project cleanup rates/times assuming that the fuel calibration area source will be removed or otherwise isolated from groundwater. The final design should be capable of remediating contaminated groundwater to target cleanup levels within a reasonable time frame (30 years or less), and should offer significant advantages over natural processes in terms of cleanup rate and/or protection of receptors. This design should be considered as conceptual only - additional data, i.e., aquifer characteristics, contaminant distributions are needed for a final design.

Basis of Design Data: (Input cells yellow, blue automatically calculated)

Groundwater Plume Information

Plume Width (W):	270	ft.
Plume Thickness:	57	ft.
Plume Area:	99,700	ft^2
Volume of Groundwater in Plume:	1420725	ft^3
Avg Hydraulic Conductivity, Plume Area:	100	ft/day

Aquifer Characteristics

Thickness (B):	57	ft.
Avg. Hydraulic Conductivity (K):	100	ft/day
Transmissivity (T):	5700	ft^2/day
Porosity (n):	0.25	
Storativity (S):	0.07	
Fractional Organic Carbon Content (foc):	0.001	
Flow Gradient (i):	0.0017	

Contaminant Characteristics

Contaminant A Representative gw conc.:	xylenes	17	ug/L
Contaminant B Representative gw conc.:			
Koc, Contaminant A:		407	
Koc, Contaminant B:			
Kd, Contaminant A:		0.407	
Kd, Contaminant B:		0	
Half-life, Contaminant A:			years
Half-life, Contaminant B:			years
Target Cleanup Level, Contaminant A:		5	ug/L
Target Cleanup Level, Contaminant B:			ug/L

Remedial System Information

Extraction Well Radius, (r) :	0.25	ft.
Time to Reach Steady-State Drawdown (t):	30	days
Allowable Drawdown, Single Well, (s):	5	ft.

Technical Approach:

Using aquifer characteristics, plume volume, Kd, half-life, and representative groundwater concentration data, calculate the number of pore volume flushes and times required to reach the target groundwater concentration (performed using the attached spreadsheets). Use standard equations to calculate the minimum required pumping rate for plume containment, per-well achievable pumping rates, and well spacings. Develop a preliminary extraction system design based on the calculations, adjusting the design as appropriate based on data limitation considerations and best scientific judgement.

Required Pumping Rate (Qt) for Total Plume Capture

Qt = TiW x 2 (2x the natural groundwater flow-thru rate for entire aquifer)

Qt = 2616.30 ft^3/day x 2, or 13.59 gpm x 2

Qt = 5232.60 ft^3/day, or 27.18 gpm

Maximum Achievable Pumping Rate in a Single Well (Qa)

Qa = $[4\pi Ts/2.3] / \log [2.25Tt/r^2S]$

Qa = 19600.98 ft^3/day, or 101.82 gpm

Minimum Number of Extraction Wells Required

= Qt/Qa

= 0.27 wells

Plume Cleanup Rate Projections (From Spreadsheet Program or Other Source)

At	20.0 gpm,	8.4 years
At	25.0 gpm,	6.7 years
At	30.0 gpm,	5.6 years
At natural GW flow rate: (plume area only)	13.59 gpm,	12.4 years

Contaminant that cleanup rate is based on: xylenes

Based on the limiting conditions calculated above, projections regarding cleanup times at various pumping rates (see accompanying spreadsheets), a suitable safety factor based on the degree of confidence in the design data, and best scientific judgement, the following are the number of extraction wells and pumping rates selected for the design:

Number of Wells:	4	
Per-well Pumping Rate (Qw):	6 gpm, or	1155.06 ft^3/day
Total System Pumping Rate (Qes):	24 gpm, or	4620.24 ft^3/day

Extraction Well Spacings, (WSp), ft Perpendicular to Groundwater Flow Direction

WSp = $Qw/\pi Ti$, for a 2-well extraction system

WSp = 37.94 ft

or

WSp = $1.26(Qw)/\pi Ti$, for a 3-well extraction system

WSp = 47.81 ft

or

WSp = $1.2(Qw)/\pi Ti$, for an extraction system with 4+ wells

WSp = 45.53 ft

Downgradient Stagnation Point (SPd) Approximation

SPd = $Qes/2\pi Ti$, Qes = total extraction system pumping rate, ft^3/day

SPd = 75.89 ft

Alternate Layout of Extraction Well System (i.e., parallel to GW flow direction):

Space wells aligned along central axis of plume and within plume interior, biased towards hot spot location(s). Use 4 wells to provide flexibility to optimize placement in hot spot areas and provide maximum efficiency r.e. contaminant mass removal.

Final Configuration, Groundwater Extraction System:

Four 6-inch diameter extraction wells, screened from 10 to 60 feet below ground, installed within the plume interior along a line parallel to the groundwater flow direction. Each well will pump at an approximate rate of 6 gpm, with a projected cleanup time of approximately 7 years after the residual source is remediated. Co-contaminants (other volatiles) will also clean up within the given time frame (assuming no residual source). Reinject treated water through infiltration trenches located along the upgradient edge of the source area. Total plume capture is not an objective as system is focused on hot spot (source area) containment/remediation only.

Heterogeneous Aquifer Flushing Rate Calculations

Project:	Claverton FC Area	Proj. No.:	1610
Chemical :	xylenes	K_{OC} (K_d*) :	407
Concentration units, water & soil (pick 1):	mg/L & mg/Kg:	ug/L & ug/Kg:	x

NOTE: Input cells are shaded yellow; cells automatically calculated are shaded blue; the remaining cells are fixed.

All groundwater/soil contaminant concentrations are in consistent units, i.e., mg/L & mg/Kg, or ug/L & ug/Kg.

This spreadsheet calculates flushing rates and cleanup times for a groundwater flow system that consists of up to 3 groundwater "flow units". Flow units are discrete portions of the aquifer that have unique properties, i.e., higher or lower average hydraulic conductivity, porosity, or specific gravity relative to other portions of the aquifer, higher/lower contaminant concentrations, and/or different organic carbon contents. The spreadsheet factors in different flushing rates for discrete portions of the aquifer based on the differences in the physical/chemical characteristics of the flow units. First-order contaminant decay/degradation processes can also be factored into the cleanup rate prediction through the optional use of contaminant half-life data.

*** for contaminants that partition between soil and water thru mechanisms other than adsoption onto organic carbon, i.e., metals, the compound's K_d is input directly into the K_{OC} entry cell, with f_{OC} then set to 1. For fractured bedrock, reduce the f_{OC} by 1-2 orders of magnitude to adjust for typical low fracture porosity and resulting high model-perceived mass of aquifer sediments in contact with water.**

Groundwater Flow Unit Physical/Chemical Data

Flow Unit 1 (U1)		Flow Unit 2 (U2)		Flow Unit 3 (U3)	
Cw_{01}	17.00	Cw_{02}	17.00	Cw_{03}	17.00
n	0.25	n	0.25	n	0.25
S_G	2.65	S_G	2.65	S_G	2.65
f_{OC}*	0.0010	f_{OC}*	0.0010	f_{OC}*	0.0010
K_d	0.407	K_d	0.407	K_d	0.407
M_W	4.250	M_W	4.250	M_W	4.250
C_S	6.919	C_S	6.919	C_S	6.919
M_S	13.752	M_S	13.752	M_S	13.752
M_T	18.002	M_T	18.002	M_T	18.002
M_S/M_T	0.7639	M_S/M_T	0.7639	M_S/M_T	0.7639

Cw_{0N} = Initial contaminant concentration in groundwater flow unit N

Groundwater Flow Unit Hydrogeologic Characteristics

Avg. K, ft/d highest to lowest	Relative average K, K_U	Fraction of aquifer volume, FV_U	Fraction of total flow, FQ_U	Flow unit number, U
331	1.000	0.33	0.715	1
100	0.302	0.34	0.220	2
30.2	0.091	0.33	0.065	3

Pore Volumes and Pore Volume Removal Rates

Groundwater discharge rate, gpm	Groundwater discharge rate, ft^3/day, Q_T	Total volume occupied by plume, ft^3, PV_T
13.6	2618.18	5,682,900

Discharge rate, Unit 1 ft^3/day, Q_1	Discharge rate, Unit 2 ft^3/day, Q_2	Discharge rate, Unit 3 ft^3/day, Q_3	Plume pore Vol., Unit 1 ft^3, PV_1	Plume pore Vol., Unit 2 ft^3, PV_2	Plume pore Vol., Unit 3 ft^3, PV_3	Time for 1 PV flush, Unit 1, days, t_1	Time for 1 PV flush, Unit 2, days, t_2	Time for 1 PV flush, Unit 3, days, t_3
1870.90	576.59	170.70	468839.25	483046.5	468839.25	250.60	837.77	2746.60

Contaminant Half-Life Data

Does contaminant have a decay half-life (yes/no):	no	If yes, half-life (days):	365
1st order decay coefficient (k):	0.001899		

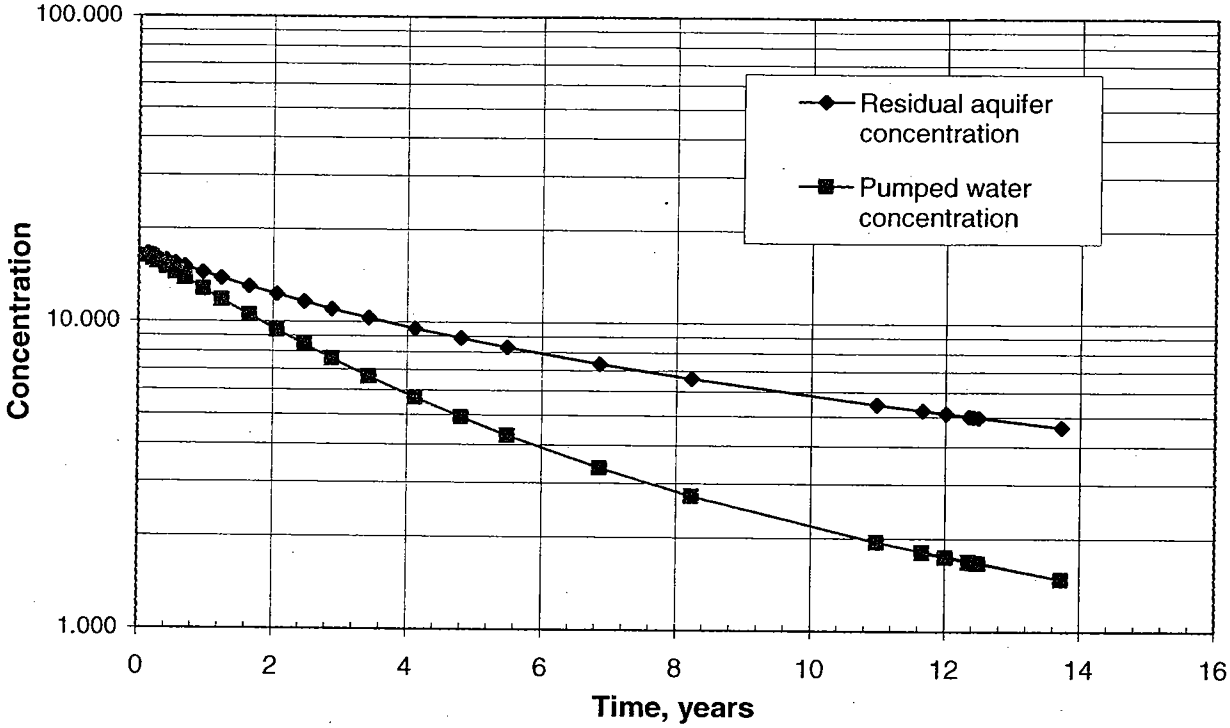
Average Pumped/Discharged and Residual Plume Concentrations Over Time

Target Cleanup Concentration :		5	ug/L	
Time period	Time span, days, t	Avg pumped GW conc.	Avg residual GW conc.	Time span, years
0	0	0	**17**	0
0.2	50.12	16.298	**16.586**	0.14
0.3	75.18	15.960	**16.385**	0.21
0.4	100.24	15.630	**16.189**	0.27
0.6	150.36	14.995	**15.808**	0.41
0.8	200.48	14.390	**15.443**	0.55
1	250.60	13.815	**15.092**	0.69
1.4	350.83	12.748	**14.432**	0.96
1.8	451.07	11.780	**13.822**	1.23
2.4	601.43	10.496	**12.992**	1.65
3	751.79	9.385	**12.251**	2.06
3.6	902.15	8.423	**11.588**	2.47
4.2	1052.50	7.589	**10.991**	2.88
5	1252.98	6.643	**10.285**	3.43
6	1503.58	5.679	**9.521**	4.12
7	1754.17	4.908	**8.864**	4.80
8	2004.77	4.285	**8.294**	5.49
10	2505.96	3.362	**7.350**	6.86
12	3007.15	2.729	**6.597**	8.23
16	4009.54	1.943	**5.455**	10.98
20	5011.92	1.481	**4.612**	13.72
17	4260.13	1.807	**5.222**	11.66
17.5	4385.43	1.744	**5.111**	12.01
18	4510.73	1.686	**5.005**	12.35
18.1	4535.79	1.674	**4.984**	12.42
18.2	4560.85	1.663	**4.963**	12.49

Adjust the initial time period to auto-adjust the following 19 time periods and obtain the desired range in concentrations.

The last 5 time periods can be modified to more precisely determine the time required to meet a specific residual concentration.

Contaminant Concentration Trend Over Time



Heterogeneous Aquifer Flushing Rate Calculations

Project:	Claverton FC Area	Proj. No.:	1610
Chemical :	xylenes	K_{OC} (K_d*) :	407
Concentration units, water & soil (pick 1):	mg/L & mg/Kg:	ug/L & ug/Kg:	x

NOTE: Input cells are shaded yellow; cells automatically calculated are shaded blue; the remaining cells are fixed.

All groundwater/soil contaminant concentrations are in consistent units, i.e., mg/L & mg/Kg, or ug/L & ug/Kg.

This spreadsheet calculates flushing rates and cleanup times for a groundwater flow system that consists of up to 3 groundwater "flow units". Flow units are discrete portions of the aquifer that have unique properties, i.e., higher or lower average hydraulic conductivity, porosity, or specific gravity relative to other portions of the aquifer, higher/lower contaminant concentrations, and/or different organic carbon contents. The spreadsheet factors in different flushing rates for discrete portions of the aquifer based on the differences in the physical/chemical characteristics of the flow units. First-order contaminant decay/degradation processes can also be factored into the cleanup rate prediction through the optional use of contaminant half-life data.

*** for contaminants that partition between soil and water thru mechanisms other than adsoption onto organic carbon, i.e., metals, the compound's K_d is input directly into the K_{OC} entry cell, with f_{OC} then set to 1. For fractured bedrock, reduce the f_{OC} by 1-2 orders of magnitude to adjust for typical low fracture porosity and resulting high model-perceived mass of aquifer sediments in contact with water.**

Groundwater Flow Unit Physical/Chemical Data

Flow Unit 1 (U1)		Flow Unit 2 (U2)		Flow Unit 3 (U3)	
Cw_{01}	17.00	Cw_{02}	17.00	Cw_{03}	17.00
n	0.25	n	0.25	n	0.25
S_G	2.65	S_G	2.65	S_G	2.65
f_{OC}*	0.0010	f_{OC}*	0.0010	f_{OC}*	0.0010
K_d	0.407	K_d	0.407	K_d	0.407
M_W	4.250	M_W	4.250	M_W	4.250
C_S	6.919	C_S	6.919	C_S	6.919
M_S	13.752	M_S	13.752	M_S	13.752
M_T	18.002	M_T	18.002	M_T	18.002
M_S/M_T	0.7639	M_S/M_T	0.7639	M_S/M_T	0.7639

Cw_{0N} = Initial contaminant concentration in groundwater flow unit N

Groundwater Flow Unit Hydrogeologic Characteristics

Avg. K, ft/d highest to lowest	Relative average K, K_U	Fraction of aquifer volume, FV_U	Fraction of total flow, FQ_U	Flow unit number, U
331	1.000	0.33	0.715	1
100	0.302	0.34	0.220	2
30.2	0.091	0.33	0.065	3

Pore Volumes and Pore Volume Removal Rates

Groundwater discharge rate, gpm	Groundwater discharge rate, ft³/day, Q_T	Total volume occupied by plume, ft³, PV_T
20	3850.27	5,682,900

Discharge rate, Unit 1 ft³/day, Q_1	Discharge rate, Unit 2 ft³/day, Q_2	Discharge rate, Unit 3 ft³/day, Q_3	Plume pore Vol., Unit 1 ft³, PV_1	Plume pore Vol., Unit 2 ft³, PV_2	Plume pore Vol., Unit 3 ft³, PV_3	Time for 1 PV flush, Unit 1, days, t_1	Time for 1 PV flush, Unit 2, days, t_2	Time for 1 PV flush, Unit 3, days, t_3
2751.32	847.92	251.03	468839.25	483046.5	468839.25	170.41	569.68	1867.69

Contaminant Half-Life Data

Does contaminant have a decay half-life (yes/no):	no	If yes, half-life (days):	365
1st order decay coefficient (k):	0.001899		

Average Pumped/Discharged and Residual Plume Concentrations Over Time

Target Cleanup Concentration :		5	ug/L	
Time period	Time span, days, t	Avg pumped GW conc.	Avg residual GW conc.	Time span, years
0	0	0	17	0
0.2	34.08	16.298	**16.586**	0.09
0.3	51.12	15.960	**16.385**	0.14
0.4	68.16	15.630	**16.189**	0.19
0.6	102.24	14.995	**15.808**	0.28
0.8	136.32	14.390	**15.443**	0.37
1	170.41	13.815	**15.092**	0.47
1.4	238.57	12.748	**14.432**	0.65
1.8	306.73	11.780	**13.822**	0.84
2.4	408.97	10.496	**12.992**	1.12
3	511.22	9.385	**12.251**	1.40
3.6	613.46	8.423	**11.588**	1.68
4.2	715.70	7.589	**10.991**	1.96
5	852.03	6.643	**10.285**	2.33
6	1022.43	5.679	**9.521**	2.80
7	1192.84	4.908	**8.864**	3.27
8	1363.24	4.285	**8.294**	3.73
10	1704.05	3.362	**7.350**	4.67
12	2044.86	2.729	**6.597**	5.60
16	2726.49	1.943	**5.455**	7.46
20	3408.11	1.481	**4.612**	9.33
17	2896.89	1.807	**5.222**	7.93
17.5	2982.09	1.744	**5.111**	8.16
18	3067.30	1.686	**5.005**	8.40
18.1	3084.34	1.674	**4.984**	8.44
18.2	3101.38	1.663	**4.963**	8.49

Adjust the initial time period to auto-adjust the following 19 time periods and obtain the desired range in concentrations.

The last 5 time periods can be modified to more precisely determine the time required to meet a specific residual concentration.

Heterogeneous Aquifer Flushing Rate Calculations

Project:	Claverton FC Area	Proj. No.:	1610
Chemical :	xylenes	K_{OC} (K_d*) :	407
Concentration units, water & soil (pick 1):	mg/L & mg/Kg:	ug/L & ug/Kg:	x

NOTE: Input cells are shaded yellow; cells automatically calculated are shaded blue; the remaining cells are fixed.

This spreadsheet calculates flushing rates and cleanup times for a groundwater flow system that consists of up to 3 groundwater "flow units". Flow units are discrete portions of the aquifer that have unique properties, i.e., higher or lower average hydraulic conductivity, porosity, or specific gravity relative to other portions of the aquifer, higher/lower contaminant concentrations, and/or different organic carbon contents. The spreadsheet factors in different flushing rates for discrete portions of the aquifer based on the differences in the physical/chemical characteristics of the flow units. First-order contaminant decay/degradation processes can also be factored into the cleanup rate prediction through the optional use of contaminant half-life data.

All groundwater/soil contaminant concentrations are in consistent units, i.e., mg/L & mg/Kg, or ug/L & ug/Kg.

*** for contaminants that partition between soil and water thru mechanisms other than adsoption onto organic carbon, i.e., metals, the compound's K_d is input directly into the K_{OC} entry cell, with f_{OC} then set to 1. For fractured bedrock, reduce the f_{OC} by 1-2 orders of magnitude to adjust for typical low fracture porosity and resulting high model-perceived mass of aquifer sediments in contact with water.**

Groundwater Flow Unit Physical/Chemical Data

Flow Unit 1 (U1)		Flow Unit 2 (U2)		Flow Unit 3 (U3)	
Cw_{01}	17.00	Cw_{02}	17.00	Cw_{03}	17.00
n	0.25	n	0.25	n	0.25
S_G	2.65	S_G	2.65	S_G	2.65
f_{OC}*	0.0010	f_{OC}*	0.0010	f_{OC}*	0.0010
K_d	0.407	K_d	0.407	K_d	0.407
M_W	4.250	M_W	4.250	M_W	4.250
C_S	6.919	C_S	6.919	C_S	6.919
M_S	13.752	M_S	13.752	M_S	13.752
M_T	18.002	M_T	18.002	M_T	18.002
M_S/M_T	0.7639	M_S/M_T	0.7639	M_S/M_T	0.7639

Cw_{0N} = Initial contaminant concentration in groundwater flow unit N

Groundwater Flow Unit Hydrogeologic Characteristics

Avg. K, ft/d highest to lowest	Relative average K, K_U	Fraction of aquifer volume, FV_U	Fraction of total flow, FQ_U	Flow unit number, U
331	1.000	0.33	0.715	1
100	0.302	0.34	0.220	2
30.2	0.091	0.33	0.065	3

Pore Volumes and Pore Volume Removal Rates

Groundwater discharge rate, gpm	Groundwater discharge rate, ft^3/day, Q_T	Total volume occupied by plume, ft^3, PV_T
25	4812.83	5,682,900

Discharge rate, Unit 1 ft^3/day, Q_1	Discharge rate, Unit 2 ft^3/day, Q_2	Discharge rate, Unit 3 ft^3/day, Q_3	Plume pore Vol., Unit 1 ft^3, PV_1	Plume pore Vol., Unit 2 ft^3, PV_2	Plume pore Vol., Unit 3 ft^3, PV_3	Time for 1 PV flush, Unit 1, days, t_1	Time for 1 PV flush, Unit 2, days, t_2	Time for 1 PV flush, Unit 3, days, t_3
3439.15	1059.90	313.78	468839.25	483046.5	468839.25	136.32	455.75	1494.15

Contaminant Half-Life Data

Does contaminant have a decay half-life (yes/no):	no	If yes, half-life (days):	365
1st order decay coefficient (k):	0.001899		

Average Pumped/Discharged and Residual Plume Concentrations Over Time

Target Cleanup Concentration :			5	ug/L
Time period	Time span, days, t	Avg pumped GW conc.	Avg residual GW conc.	Time span, years
0	0	0	17	0
0.2	27.26	16.298	16.586	0.07
0.3	40.90	15.960	16.385	0.11
0.4	54.53	15.630	16.189	0.15
0.6	81.79	14.995	15.808	0.22
0.8	109.06	14.390	15.443	0.30
1	136.32	13.815	15.092	0.37
1.4	190.85	12.748	14.432	0.52
1.8	245.38	11.780	13.822	0.67
2.4	327.18	10.496	12.992	0.90
3	408.97	9.385	12.251	1.12
3.6	490.77	8.423	11.588	1.34
4.2	572.56	7.589	10.991	1.57
5	681.62	6.643	10.285	1.87
6	817.95	5.679	9.521	2.24
7	954.27	4.908	8.864	2.61
8	1090.59	4.285	8.294	2.99
10	1363.24	3.362	7.350	3.73
12	1635.89	2.729	6.597	4.48
16	2181.19	1.943	5.455	5.97
20	2726.49	1.481	4.612	7.46
17	2317.51	1.807	5.222	6.35
17.5	2385.67	1.744	5.111	6.53
18	2453.84	1.686	5.005	6.72
18.1	2467.47	1.674	4.984	6.76
18.2	2481.10	1.663	4.963	6.79

Adjust the initial time period to auto-adjust the following 19 time periods and obtain the desired range in concentrations.

The last 5 time periods can be modified to more precisely determine the time required to meet a specific residual concentration.

Heterogeneous Aquifer Flushing Rate Calculations

Project:	Claverton FC Area	Proj. No.:	1610
Chemical :	xylenes	K_{OC} (K_d*) :	407
Concentration units, water & soil (pick 1):	mg/L & mg/Kg:	ug/L & ug/Kg:	x

NOTE: Input cells are shaded yellow; cells automatically calculated are shaded blue; the remaining cells are fixed.

This spreadsheet calculates flushing rates and cleanup times for a groundwater flow system that consists of up to 3 groundwater "flow units". Flow units are discrete portions of the aquifer that have unique properties, i.e., higher or lower average hydraulic conductivity, porosity, or specific gravity relative to other portions of the aquifer, higher/lower contaminant concentrations, and/or different organic carbon contents. The spreadsheet factors in different flushing rates for discrete portions of the aquifer based on the differences in the physical/chemical characteristics of the flow units. First-order contaminant decay/degradation processes can also be factored into the cleanup rate prediction through the optional use of contaminant half-life data.

All groundwater/soil contaminant concentrations are in consistent units, i.e., mg/L & mg/Kg, or ug/L & ug/Kg.

* for contaminants that partition between soil and water thru mechanisms other than adsoption onto organic carbon, i.e., metals, the compound's K_d is input directly into the K_{OC} entry cell, with f_{OC} then set to 1. For fractured bedrock, reduce the f_{OC} by 1-2 orders of magnitude to adjust for typical low fracture porosity and resulting high model-perceived mass of aquifer sediments in contact with water.

Groundwater Flow Unit Physical/Chemical Data

Flow Unit 1 (U1)		Flow Unit 2 (U2)		Flow Unit 3 (U3)	
Cw_{01}	17.00	Cw_{02}	17.00	Cw_{03}	17.00
n	0.25	n	0.25	n	0.25
S_G	2.65	S_G	2.65	S_G	2.65
f_{OC}*	0.0010	f_{OC}*	0.0010	f_{OC}*	0.0010
K_d	0.407	K_d	0.407	K_d	0.407
M_W	4.250	M_W	4.250	M_W	4.250
C_S	6.919	C_S	6.919	C_S	6.919
M_S	13.752	M_S	13.752	M_S	13.752
M_T	18.002	M_T	18.002	M_T	18.002
M_S/M_T	0.7639	M_S/M_T	0.7639	M_S/M_T	0.7639

Cw_{0N} = Initial contaminant concentration in groundwater flow unit N

Groundwater Flow Unit Hydrogeologic Characteristics

Avg. K, ft/d highest to lowest	Relative average K, K_U	Fraction of aquifer volume, FV_U	Fraction of total flow, FQ_U	Flow unit number, U
331	1.000	0.33	0.715	1
100	0.302	0.34	0.220	2
30.2	0.091	0.33	0.065	3

Pore Volumes and Pore Volume Removal Rates

Groundwater discharge rate, gpm	Groundwater discharge rate, ft^3/day, Q_T	Total volume occupied by plume, ft^3, PV_T
30	5775.40	5,682,900

Discharge rate, Unit 1 ft^3/day, Q_1	Discharge rate, Unit 2 ft^3/day, Q_2	Discharge rate, Unit 3 ft^3/day, Q_3	Plume pore Vol., Unit 1 ft^3, PV_1	Plume pore Vol., Unit 2 ft^3, PV_2	Plume pore Vol., Unit 3 ft^3, PV_3	Time for 1 PV flush, Unit 1, days, t_1	Time for 1 PV flush, Unit 2, days, t_2	Time for 1 PV flush, Unit 3, days, t_3
4126.98	1271.88	376.54	468839.25	483046.5	468839.25	113.60	379.79	1245.12

Contaminant Half-Life Data

Does contaminant have a decay half-life (yes/no):	no	If yes, half-life (days):	365
1st order decay coefficient (k):	0.001899		

Average Pumped/Discharged and Residual Plume Concentrations Over Time

Target Cleanup Concentration :			5	ug/L
Time period	Time span, days, t	Avg pumped GW conc.	Avg residual GW conc.	Time span, years
0	0	0	17	0
0.2	22.72	16.298	16.586	0.06
0.3	34.08	15.960	16.385	0.09
0.4	45.44	15.630	16.189	0.12
0.6	68.16	14.995	15.808	0.19
0.8	90.88	14.390	15.443	0.25
1	113.60	13.815	15.092	0.31
1.4	159.04	12.748	14.432	0.44
1.8	204.49	11.780	13.822	0.56
2.4	272.65	10.496	12.992	0.75
3	340.81	9.385	12.251	0.93
3.6	408.97	8.423	11.588	1.12
4.2	477.13	7.589	10.991	1.31
5	568.02	6.643	10.289	1.56
6	681.62	5.679	9.521	1.87
7	795.22	4.908	8.864	2.18
8	908.83	4.285	8.294	2.49
10	1136.04	3.362	7.350	3.11
12	1363.24	2.729	6.597	3.73
16	1817.66	1.943	5.455	4.98
20	2272.07	1.481	4.612	6.22
17	1931.26	1.807	5.222	5.29
17.5	1988.06	1.744	5.111	5.44
18	2044.86	1.686	5.005	5.60
18.1	2056.22	1.674	4.984	5.63
18.2	2067.58	1.663	4.963	5.66

Adjust the initial time period to auto-adjust the following 19 time periods and obtain the desired range in concentrations.

The last 5 time periods can be modified to more precisely determine the time required to meet a specific residual concentration.

Project:	NWIRP Calverton	Project No.:	1610
Subject:	FC Area (Site 6A) Groundwater Extraction System FS Designs		
By:	JPO	Date:	10/4/2005
Checked:		Date:	

Project/Design Objective:

Design a groundwater extraction system for containment/cleanup of the source area for the chlorinated VOC/BTEX plume in the shallow groundwater flow system. Project cleanup rates/times assuming that the fuel calibration area source will be removed or otherwise isolated from groundwater. The final design should be capable of remediating contaminated groundwater to target cleanup levels within a reasonable time frame (30 years or less), and should offer significant advantages over natural processes in terms of cleanup rate and/or protection of receptors. This design should be considered as conceptual only - additional data, i.e., aquifer characteristics, contaminant distributions are needed for a final design.

Basis of Design Data: (Input cells yellow, blue automatically calculated)

Groundwater Plume Information

Plume Width (W):	270	ft.
Plume Thickness:	57	ft.
Plume Area:	99,700	ft^2
Volume of Groundwater in Plume:	1420725	ft^3
Avg Hydraulic Conductivity, Plume Area:	100	ft/day

Aquifer Characteristics

Thickness (B):	57	ft.
Avg. Hydraulic Conductivity (K):	100	ft/day
Transmissivity (T):	5700	ft^2/day
Porosity (n):	0.25	
Storativity (S):	0.07	
Fractional Organic Carbon Content (foc):	0.001	
Flow Gradient (i):	0.0017	

Contaminant Characteristics

Contaminant A Representative gw conc.:	naphthalene	120	ug/L
Contaminant B Representative gw conc.:	4 methylphenol	84	
Koc, Contaminant A:		2,000	
Koc, Contaminant B:		500	
Kd, Contaminant A:		2	
Kd, Contaminant B:		0.5	
Half-life, Contaminant A:			years
Half-life, Contaminant B:			years
Target Cleanup Level, Contaminant A:		10	ug/L
Target Cleanup Level, Contaminant B:		5	ug/L

Remedial System Information

Extraction Well Radius, (r) :	0.25	ft.
Time to Reach Steady-State Drawdown (t):	30	days
Allowable Drawdown, Single Well, (s):	5	ft.

Technical Approach:

Using aquifer characteristics, plume volume, Kd, half-life, and representative groundwater concentration data, calculate the number of pore volume flushes and times required to reach the target groundwater concentration (performed using the attached spreadsheets). Use standard equations to calculate the minimum required pumping rate for plume containment, per-well achievable pumping rates, and well spacings. Develop a preliminary extraction system design based on the calculations, adjusting the design as appropriate based on data limitation considerations and best scientific judgement.

Minimum Required Total Pumping Rate (Qt)

Qt = TiW x 2 (2x the natural groundwater flow-thru rate for entire aquifer)

Qt = 2616.30 ft^3/day x 2, or 13.59 gpm x 2

Qt = 5232.60 ft^3/day, or 27.18 gpm

Maximum Achievable Pumping Rate in a Single Well (Qa)

Qa = $[4\pi Ts/2.3] / \log [2.25Tt/r^2S]$

Qa = 19600.98 ft^3/day, or 101.82 gpm

Minimum Number of Extraction Wells Required

= Qt/Qa

= 0.27 wells

Plume Cleanup Rate Projections (From Spreadsheet Program or Other Source)

At	27.2	gpm,	87.5	years
At	60.0	gpm,	40	years
At	80.0	gpm,	29.7	years
At natural GW flow rate: (plume area only)	13.59	gpm,	175	years

Contaminant that cleanup rate is based on: naphthalene

Based on the limiting conditions calculated above, projections regarding cleanup times at various pumping rates (see accompanying spreadsheets), a suitable safety factor based on the degree of confidence in the design data, and best scientific judgement, the following are the number of extraction wells and pumping rates selected for the design:

Number of Wells:	4		
Per-well Pumping Rate (Qw):	20	gpm, or	3850.20 ft^3/day
Total System Pumping Rate (Qes):	80	gpm, or	15400.80 ft^3/day

Extraction Well Spacings, (WSp), ft Perpendicular to Groundwater Flow Direction

WSp = $Qw/\pi Ti$, for a 2-well extraction system

WSp = 126.48 ft

or

WSp = $1.26(Qw)/\pi Ti$, for a 3-well extraction system

WSp = 159.36 ft

or

WSp = $1.2(Qw)/\pi Ti$, for an extraction system with 4+ wells

WSp = 151.77 ft

Downgradient Stagnation Point (SPd) Approximation

SPd = $Qes/2\pi Ti$, Qes = total extraction system pumping rate, ft^3/day

SPd = 252.95 ft

Alternate Layout of Extraction Well System (I.e., parallel to GW flow direction):

Space wells aligned along central axis of plume and within plume interior, biased towards hot spot location(s). Use 4 wells to provide flexibility to optimize placement in hot spot areas and provide maximum efficiency r.e. contaminant mass removal.

Final Configuration, Groundwater Extraction System:

Four 6-inch diameter extraction wells, screened from 10 to 60 feet below ground, installed within the plume interior along a line parallel to the groundwater flow direction. Each well will pump at an approximate rate of 20 gpm, with a projected cleanup time of approximately 30 years after the residual source is remediated. Co-contaminants (most notably other semivolatiles) will also clean up within the given time frame (assuming no residual source). Cleanup time projection assumes 1997 SVOC data is representative of current conditions. Reinject treated water through infiltration trenches located along the upgradient edge of the source area.

Heterogeneous Aquifer Flushing Rate Calculations

Project:	Claverton FC Area	Proj. No.:	1610
Chemical :	naphthalene	K_{OC} (K_d*) :	2000
Concentration units, water & soil (pick 1):	mg/L & mg/Kg:	ug/L & ug/Kg:	x

NOTE: Input cells are shaded yellow; cells automatically calculated are shaded blue; the remaining cells are fixed.

This spreadsheet calculates flushing rates and cleanup times for a groundwater flow system that consists of up to 3 groundwater "flow units". Flow units are discrete portions of the aquifer that have unique properties, i.e., higher or lower average hydraulic conductivity, porosity, or specific gravity relative to other portions of the aquifer, higher/lower contaminant concentrations, and/or different organic carbon contents. The spreadsheet factors in different flushing rates for discrete portions of the aquifer based on the differences in the physical/chemical characteristics of the flow units. First-order contaminant decay/degradation processes can also be factored into the cleanup rate prediction through the optional use of contaminant half-life data.

All groundwater/soil contaminant concentrations are in consistent units, i.e., mg/L & mg/Kg, or ug/L & ug/Kg.

* for contaminants that partition between soil and water thru mechanisms other than adsoption onto organic carbon, i.e., metals, the compound's K_d is input directly into the K_{OC} entry cell, with f_{OC} then set to 1. For fractured bedrock, reduce the f_{OC} by 1-2 orders of magnitude to adjust for typical low fracture porosity and resulting high model-perceived mass of aquifer sediments in contact with water.

Groundwater Flow Unit Physical/Chemical Data

Flow Unit 1 (U1)		Flow Unit 2 (U2)		Flow Unit 3 (U3)	
Cw_{01}	120.00	Cw_{02}	120.00	Cw_{03}	120.00
n	0.25	n	0.25	n	0.25
S_G	2.65	S_G	2.65	S_G	2.65
f_{OC}*	0.0010	f_{OC}*	0.0010	f_{OC}*	0.0010
K_d	2.000	K_d	2.000	K_d	2.000
M_W	30.000	M_W	30.000	M_W	30.000
C_S	240.000	C_S	240.000	C_S	240.000
M_S	477.000	M_S	477.000	M_S	477.000
M_T	507.000	M_T	507.000	M_T	507.000
M_S/M_T	0.9408	M_S/M_T	0.9408	M_S/M_T	0.9408

Cw_{0N} = Initial contaminant concentration in groundwater flow unit N

Groundwater Flow Unit Hydrogeologic Characteristics

Avg. K, ft/d highest to lowest	Relative average K, K_U	Fraction of aquifer volume, FV_U	Fraction of total flow, FQ_U	Flow unit number, U
331	1.000	0.33	0.715	1
100	0.302	0.34	0.220	2
30.2	0.091	0.33	0.065	3

Pore Volumes and Pore Volume Removal Rates

Groundwater discharge rate, gpm	Groundwater discharge rate, ft^3/day, Q_T	Total volume occupied by plume, ft^3, PV_T
13.6	2618.18	5,682,900

Discharge rate, Unit 1 ft^3/day, Q_1	Discharge rate, Unit 2 ft^3/day, Q_2	Discharge rate, Unit 3 ft^3/day, Q_3	Plume pore Vol., Unit 1 ft^3, PV_1	Plume pore Vol., Unit 2 ft^3, PV_2	Plume pore Vol., Unit 3 ft^3, PV_3	Time for 1 PV flush, Unit 1, days, t_1	Time for 1 PV flush, Unit 2, days, t_2	Time for 1 PV flush, Unit 3, days, t_3
1870.90	576.59	170.70	468839.25	483046.5	468839.25	250.60	837.77	2746.60

Contaminant Half-Life Data

Does contaminant have a decay half-life (yes/no):	no	If yes, half-life (days):	365
1st order decay coefficient (k):	0.001899		

Average Pumped/Discharged and Residual Plume Concentrations Over Time

Target Cleanup Concentration :		10	ug/L	
Time period	Time span, days, t	Avg pumped GW conc.	Avg residual GW conc.	Time span, years
0	0	0	**120**	0
2	501.19	109.119	**113.552**	1.37
3	751.79	104.124	**110.549**	2.06
4	1002.38	99.404	**107.684**	2.74
6	1503.58	90.723	**102.333**	4.12
8	2004.77	82.961	**97.444**	5.49
10	2505.96	76.014	**92.970**	6.86
14	3508.34	64.214	**85.094**	9.61
18	4510.73	54.711	**78.414**	12.35
24	6014.31	43.739	**70.143**	16.47
30	7517.88	35.666	**63.467**	20.58
36	9021.46	29.647	**57.972**	24.70
42	10525.03	25.092	**53.363**	28.82
50	12529.80	20.599	**48.243**	34.30
60	15035.76	16.654	**43.031**	41.17
70	17541.72	13.868	**38.754**	48.03
80	20047.68	11.804	**35.152**	54.89
100	25059.60	8.940	**29.369**	68.61
120	30071.53	7.028	**24.903**	82.33
160	40095.37	4.643	**18.460**	109.78
200	50119.21	3.259	**14.073**	137.22
220	55131.13	2.777	**12.378**	150.94
240	60143.05	2.389	**10.926**	164.66
250	62649.01	2.222	**10.277**	171.52
255	63901.99	2.145	**9.970**	174.95
254	63651.40	2.160	**10.030**	174.27

Adjust the initial time period to auto-adjust the following 19 time periods and obtain the desired range in concentrations.

The last 5 time periods can be modified to more precisely determine the time required to meet a specific residual concentration.

Heterogeneous Aquifer Flushing Rate Calculations

Project:	Claverton FC Area	Proj. No.:	1610
Chemical :	naphthalene	K_{OC} (K_d*) :	2000
Concentration units, water & soil (pick 1):	mg/L & mg/Kg:	ug/L & ug/Kg:	x

NOTE: Input cells are shaded yellow; cells automatically calculated are shaded blue; the remaining cells are fixed.

All groundwater/soil contaminant concentrations are in consistent units, i.e., mg/L & mg/Kg, or ug/L & ug/Kg.

*** for contaminants that partition between soil and water thru mechanisms other than adsoption onto organic carbon, i.e., metals, the compound's K_d is input directly into the K_{OC} entry cell, with f_{OC} then set to 1. For fractured bedrock, reduce the f_{OC} by 1-2 orders of magnitude to adjust for typical low fracture porosity and resulting high model-perceived mass of aquifer sediments in contact with water.**

This spreadsheet calculates flushing rates and cleanup times for a groundwater flow system that consists of up to 3 groundwater "flow units". Flow units are discrete portions of the aquifer that have unique properties, i.e., higher or lower average hydraulic conductivity, porosity, or specific gravity relative to other portions of the aquifer, higher/lower contaminant concentrations, and/or different organic carbon contents. The spreadsheet factors in different flushing rates for discrete portions of the aquifer based on the differences in the physical/chemical characteristics of the flow units. First-order contaminant decay/degradation processes can also be factored into the cleanup rate prediction through the optional use of contaminant half-life data.

Groundwater Flow Unit Physical/Chemical Data

Flow Unit 1 (U1)		Flow Unit 2 (U2)		Flow Unit 3 (U3)	
Cw_{01}	120.00	Cw_{02}	120.00	Cw_{03}	120.00
n	0.25	n	0.25	n	0.25
S_G	2.65	S_G	2.65	S_G	2.65
f_{OC}*	0.0010	f_{OC}*	0.0010	f_{OC}*	0.0010
K_d	2.000	K_d	2.000	K_d	2.000
M_W	30.000	M_W	30.000	M_W	30.000
C_S	240.000	C_S	240.000	C_S	240.000
M_S	477.000	M_S	477.000	M_S	477.000
M_T	507.000	M_T	507.000	M_T	507.000
M_S/M_T	0.9408	M_S/M_T	0.9408	M_S/M_T	0.9408

Cw_{0N} = Initial contaminant concentration in groundwater flow unit N

Groundwater Flow Unit Hydrogeologic Characteristics

Avg. K, ft/d highest to lowest	Relative average K, K_U	Fraction of aquifer volume, FV_U	Fraction of total flow, FQ_U	Flow unit number, U
331	1.000	0.33	0.715	1
100	0.302	0.34	0.220	2
30.2	0.091	0.33	0.065	3

Pore Volumes and Pore Volume Removal Rates

Groundwater discharge rate, gpm	Groundwater discharge rate, ft^3/day, Q_T	Total volume occupied by plume, ft^3, PV_T
27.2	5236.36	5,682,900

Discharge rate, Unit 1 ft^3/day, Q_1	Discharge rate, Unit 2 ft^3/day, Q_2	Discharge rate, Unit 3 ft^3/day, Q_3	Plume pore Vol., Unit 1 ft^3, PV_1	Plume pore Vol., Unit 2 ft^3, PV_2	Plume pore Vol., Unit 3 ft^3, PV_3	Time for 1 PV flush, Unit 1, days, t_1	Time for 1 PV flush, Unit 2, days, t_2	Time for 1 PV flush, Unit 3, days, t_3
3741.79	1153.17	341.40	468839.25	483046.5	468839.25	125.30	418.88	1373.30

Contaminant Half-Life Data

Does contaminant have a decay half-life (yes/no):	no	If yes, half-life (days):	365
1st order decay coefficient (k):	0.001899		

Average Pumped/Discharged and Residual Plume Concentrations Over Time

Target Cleanup Concentration :		10	ug/L	
Time period	Time span, days, t	Avg pumped GW conc.	Avg residual GW conc.	Time span, years
0	0	0	**120**	0
2	250.60	109.119	**113.552**	0.69
3	375.89	104.124	**110.549**	1.03
4	501.19	99.404	**107.684**	1.37
6	751.79	90.723	**102.333**	2.06
8	1002.38	82.961	**97.444**	2.74
10	1252.98	76.014	**92.970**	3.43
14	1754.17	64.214	**85.094**	4.80
18	2255.36	54.711	**78.414**	6.17
24	3007.15	43.739	**70.143**	8.23
30	3758.94	35.666	**63.467**	10.29
36	4510.73	29.647	**57.972**	12.35
42	5262.52	25.092	**53.363**	14.41
50	6264.90	20.599	**48.243**	17.15
60	7517.88	16.654	**43.031**	20.58
70	8770.86	13.868	**38.754**	24.01
80	10023.84	11.804	**35.152**	27.44
100	12529.80	8.940	**29.369**	34.30
120	15035.76	7.028	**24.903**	41.17
160	20047.68	4.643	**18.460**	54.89
200	25059.60	3.259	**14.073**	68.61
220	27565.57	2.777	**12.378**	75.47
240	30071.53	2.389	**10.926**	82.33
250	31324.51	2.222	**10.277**	85.76
255	31951.00	2.145	**9.970**	87.48
254	31825.70	2.160	**10.030**	87.13

Adjust the initial time period to auto-adjust the following 19 time periods and obtain the desired range in concentrations.

The last 5 time periods can be modified to more precisely determine the time required to meet a specific residual concentration.

Heterogeneous Aquifer Flushing Rate Calculations

Project:	Claverton FC Area	Proj. No.:	1610
Chemical :	naphthalene	K_{OC} (K_d*) :	2000
Concentration units, water & soil (pick 1):	mg/L & mg/Kg:	ug/L & ug/Kg:	x

NOTE: Input cells are shaded yellow; cells automatically calculated are shaded blue; the remaining cells are fixed.

All groundwater/soil contaminant concentrations are in consistent units, i.e., mg/L & mg/Kg, or ug/L & ug/Kg.

*** for contaminants that partition between soil and water thru mechanisms other than adsoption onto organic carbon, i.e., metals, the compound's K_d is input directly into the K_{OC} entry cell, with f_{OC} then set to 1. For fractured bedrock, reduce the f_{OC} by 1-2 orders of magnitude to adjust for typical low fracture porosity and resulting high model-perceived mass of aquifer sediments in contact with water.**

This spreadsheet calculates flushing rates and cleanup times for a groundwater flow system that consists of up to 3 groundwater "flow units". Flow units are discrete portions of the aquifer that have unique properties, i.e., higher or lower average hydraulic conductivity, porosity, or specific gravity relative to other portions of the aquifer, higher/lower contaminant concentrations, and/or different organic carbon contents. The spreadsheet factors in different flushing rates for discrete portions of the aquifer based on the differences in the physical/chemical characteristics of the flow units. First-order contaminant decay/degradation processes can also be factored into the cleanup rate prediction through the optional use of contaminant half-life data.

Groundwater Flow Unit Physical/Chemical Data

Flow Unit 1 (U1)		Flow Unit 2 (U2)		Flow Unit 3 (U3)	
Cw_{01}	120.00	Cw_{02}	120.00	Cw_{03}	120.00
n	0.25	n	0.25	n	0.25
S_G	2.65	S_G	2.65	S_G	2.65
f_{OC}*	0.0010	f_{OC}*	0.0010	f_{OC}*	0.0010
K_d	2.000	K_d	2.000	K_d	2.000
M_W	30.000	M_W	30.000	M_W	30.000
C_S	240.000	C_S	240.000	C_S	240.000
M_S	477.000	M_S	477.000	M_S	477.000
M_T	507.000	M_T	507.000	M_T	507.000
M_S/M_T	0.9408	M_S/M_T	0.9408	M_S/M_T	0.9408

Cw_{0N} = Initial contaminant concentration in groundwater flow unit N

Groundwater Flow Unit Hydrogeologic Characteristics

Avg. K, ft/d highest to lowest	Relative average K, K_U	Fraction of aquifer volume, FV_U	Fraction of total flow, FQ_U	Flow unit number, U
331	1.000	0.33	0.715	1
100	0.302	0.34	0.220	2
30.2	0.091	0.33	0.065	3

Pore Volumes and Pore Volume Removal Rates

Groundwater discharge rate, gpm	Groundwater discharge rate, ft^3/day, Q_T	Total volume occupied by plume, ft^3, PV_T
40	7700.53	5,682,900

Discharge rate, Unit 1 ft^3/day, Q_1	Discharge rate, Unit 2 ft^3/day, Q_2	Discharge rate, Unit 3 ft^3/day, Q_3	Plume pore Vol., Unit 1 ft^3, PV_1	Plume pore Vol., Unit 2 ft^3, PV_2	Plume pore Vol., Unit 3 ft^3, PV_3	Time for 1 PV flush, Unit 1, days, t_1	Time for 1 PV flush, Unit 2, days, t_2	Time for 1 PV flush, Unit 3, days, t_3
5502.64	1695.84	502.05	468839.25	483046.5	468839.25	85.20	284.84	933.84

Contaminant Half-Life Data

Does contaminant have a decay half-life (yes/no):	no	If yes, half-life (days):	365
1st order decay coefficient (k):	0.001899		

Average Pumped/Discharged and Residual Plume Concentrations Over Time

Target Cleanup Concentration :			10	ug/L
Time period	Time span, days, t	Avg pumped GW conc.	Avg residual GW conc.	Time span, years
0	0	0	**120**	0
2	170.41	109.119	**113.552**	0.47
3	255.61	104.124	**110.549**	0.70
4	340.81	99.404	**107.684**	0.93
6	511.22	90.723	**102.333**	1.40
8	681.62	82.961	**97.444**	1.87
10	852.03	76.014	**92.970**	2.33
14	1192.84	64.214	**85.094**	3.27
18	1533.65	54.711	**78.414**	4.20
24	2044.86	43.739	**70.143**	5.60
30	2556.08	35.666	**63.467**	7.00
36	3067.30	29.647	**57.972**	8.40
42	3578.51	25.092	**53.363**	9.80
50	4260.13	20.599	**48.243**	11.66
60	5112.16	16.654	**43.031**	14.00
70	5964.19	13.868	**38.754**	16.33
80	6816.21	11.804	**35.152**	18.66
100	8520.27	8.940	**29.369**	23.33
120	10224.32	7.028	**24.903**	27.99
160	13632.43	4.643	**18.460**	37.32
200	17040.53	3.259	**14.073**	46.65
220	18744.58	2.777	**12.378**	51.32
240	20448.64	2.389	**10.926**	55.99
250	21300.66	2.222	**10.277**	58.32
255	21726.68	2.145	**9.970**	59.48
254	21641.47	2.160	**10.030**	59.25

Adjust the initial time period to auto-adjust the following 19 time periods and obtain the desired range in concentrations.

The last 5 time periods can be modified to more precisely determine the time required to meet a specific residual concentration.

Heterogeneous Aquifer Flushing Rate Calculations

Project: Claverton FC Area		Proj. No.:	1610
Chemical : naphthalene		K_{OC} (K_d*) :	2000
Concentration units, water & soil (pick 1):	mg/L & mg/Kg:	ug/L & ug/Kg:	x

NOTE: Input cells are shaded yellow; cells automatically calculated are shaded blue; the remaining cells are fixed.

All groundwater/soil contaminant concentrations are in consistent units, i.e., mg/L & mg/Kg, or ug/L & ug/Kg.

This spreadsheet calculates flushing rates and cleanup times for a groundwater flow system that consists of up to 3 groundwater "flow units". Flow units are discrete portions of the aquifer that have unique properties, i.e., higher or lower average hydraulic conductivity, porosity, or specific gravity relative to other portions of the aquifer, higher/lower contaminant concentrations, and/or different organic carbon contents. The spreadsheet factors in different flushing rates for discrete portions of the aquifer based on the differences in the physical/chemical characteristics of the flow units. First-order contaminant decay/degradation processes can also be factored into the cleanup rate prediction through the optional use of contaminant half-life data.

*** for contaminants that partition between soil and water thru mechanisms other than adsoption onto organic carbon, i.e., metals, the compound's K_d is input directly into the K_{OC} entry cell, with f_{OC} then set to 1. For fractured bedrock, reduce the f_{OC} by 1-2 orders of magnitude to adjust for typical low fracture porosity and resulting high model-perceived mass of aquifer sediments in contact with water.**

Groundwater Flow Unit Physical/Chemical Data

Flow Unit 1 (U1)		Flow Unit 2 (U2)		Flow Unit 3 (U3)	
Cw_{01}	120.00	Cw_{02}	120.00	Cw_{03}	120.00
n	0.25	n	0.25	n	0.25
S_G	2.65	S_G	2.65	S_G	2.65
f_{OC}*	0.0010	f_{OC}*	0.0010	f_{OC}*	0.0010
K_d	2.000	K_d	2.000	K_d	2.000
M_W	30.000	M_W	30.000	M_W	30.000
C_S	240.000	C_S	240.000	C_S	240.000
M_S	477.000	M_S	477.000	M_S	477.000
M_T	507.000	M_T	507.000	M_T	507.000
M_S/M_T	0.9408	M_S/M_T	0.9408	M_S/M_T	0.9408

Cw_{0N} = Initial contaminant concentration in groundwater flow unit N

Groundwater Flow Unit Hydrogeologic Characteristics

Avg. K, ft/d highest to lowest	Relative average K, K_U	Fraction of aquifer volume, FV_U	Fraction of total flow, FQ_U	Flow unit number, U
331	1.000	0.33	0.715	1
100	0.302	0.34	0.220	2
30.2	0.091	0.33	0.065	3

Pore Volumes and Pore Volume Removal Rates

Groundwater discharge rate, gpm	Groundwater discharge rate, ft^3/day, Q_T	Total volume occupied by plume, ft^3, PV_T
60	11550.80	5,682,900

Discharge rate, Unit 1 ft^3/day, Q_1	Discharge rate, Unit 2 ft^3/day, Q_2	Discharge rate, Unit 3 ft^3/day, Q_3	Plume pore Vol., Unit 1 ft^3, PV_1	Plume pore Vol., Unit 2 ft^3, PV_2	Plume pore Vol., Unit 3 ft^3, PV_3	Time for 1 PV flush, Unit 1, days, t_1	Time for 1 PV flush, Unit 2, days, t_2	Time for 1 PV flush, Unit 3, days, t_3
8253.95	2543.77	753.08	468839.25	483046.5	468839.25	56.80	189.89	622.56

Contaminant Half-Life Data

Does contaminant have a decay half-life (yes/no):	no	If yes, half-life (days):	365
1st order decay coefficient (k):	0.001899		

Average Pumped/Discharged and Residual Plume Concentrations Over Time

Target Cleanup Concentration :			10	ug/L
Time period	Time span, days, t	Avg pumped GW conc.	Avg residual GW conc.	Time span, years
0	0	0	120	0
2	113.60	109.119	113.552	0.31
3	170.41	104.124	110.549	0.47
4	227.21	99.404	107.684	0.62
6	340.81	90.723	102.333	0.93
8	454.41	82.961	97.444	1.24
10	568.02	76.014	92.970	1.56
14	795.22	64.214	85.094	2.18
18	1022.43	54.711	78.414	2.80
24	1363.24	43.739	70.143	3.73
30	1704.05	35.666	63.467	4.67
36	2044.86	29.647	57.972	5.60
42	2385.67	25.092	53.363	6.53
50	2840.09	20.599	48.243	7.78
60	3408.11	16.654	43.031	9.33
70	3976.12	13.868	38.754	10.89
80	4544.14	11.804	35.152	12.44
100	5680.18	8.940	29.369	15.55
120	6816.21	7.028	24.903	18.66
160	9088.28	4.643	18.460	24.88
200	11360.35	3.259	14.073	31.10
220	12496.39	2.777	12.378	34.21
240	13632.43	2.389	10.926	37.32
250	14200.44	2.222	10.277	38.88
255	14484.45	2.145	9.970	39.66
254	14427.65	2.160	10.030	39.50

Adjust the initial time period to auto-adjust the following 19 time periods and obtain the desired range in concentrations.

The last 5 time periods can be modified to more precisely determine the time required to meet a specific residual concentration.

Heterogeneous Aquifer Flushing Rate Calculations

Project:	Claverton FC Area	Proj. No.:	1610
Chemical :	naphthalene	K_{OC} (K_d*) :	2000
Concentration units, water & soil (pick 1):	mg/L & mg/Kg:	ug/L & ug/Kg:	x

NOTE: Input cells are shaded yellow; cells automatically calculated are shaded blue; the remaining cells are fixed.

This spreadsheet calculates flushing rates and cleanup times for a groundwater flow system that consists of up to 3 groundwater "flow units". Flow units are discrete portions of the aquifer that have unique properties, i.e., higher or lower average hydraulic conductivity, porosity, or specific gravity relative to other portions of the aquifer, higher/lower contaminant concentrations, and/or different organic carbon contents. The spreadsheet factors in different flushing rates for discrete portions of the aquifer based on the differences in the physical/chemical characteristics of the flow units. First-order contaminant decay/degradation processes can also be factored into the cleanup rate prediction through the optional use of contaminant half-life data.

All groundwater/soil contaminant concentrations are in consistent units, i.e., mg/L & mg/Kg, or ug/L & ug/Kg.

*** for contaminants that partition between soil and water thru mechanisms other than adsoption onto organic carbon, i.e., metals, the compound's K_d is input directly into the K_{OC} entry cell, with f_{OC} then set to 1. For fractured bedrock, reduce the f_{OC} by 1-2 orders of magnitude to adjust for typical low fracture porosity and resulting high model-perceived mass of aquifer sediments in contact with water.**

Groundwater Flow Unit Physical/Chemical Data

Flow Unit 1 (U1)		Flow Unit 2 (U2)		Flow Unit 3 (U3)	
Cw_{01}	120.00	Cw_{02}	120.00	Cw_{03}	120.00
n	0.25	n	0.25	n	0.25
S_G	2.65	S_G	2.65	S_G	2.65
f_{OC}*	0.0010	f_{OC}*	0.0010	f_{OC}*	0.0010
K_d	2.000	K_d	2.000	K_d	2.000
M_W	30.000	M_W	30.000	M_W	30.000
C_S	240.000	C_S	240.000	C_S	240.000
M_S	477.000	M_S	477.000	M_S	477.000
M_T	507.000	M_T	507.000	M_T	507.000
M_S/M_T	0.9408	M_S/M_T	0.9408	M_S/M_T	0.9408

Cw_{0N} = Initial contaminant concentration in groundwater flow unit N

Groundwater Flow Unit Hydrogeologic Characteristics

Avg. K, ft/d highest to lowest	Relative average K, K_U	Fraction of aquifer volume, FV_U	Fraction of total flow, FQ_U	Flow unit number, U
331	1.000	0.33	0.715	1
100	0.302	0.34	0.220	2
30.2	0.091	0.33	0.065	3

Pore Volumes and Pore Volume Removal Rates

Groundwater discharge rate, gpm	Groundwater discharge rate, ft^3/day, Q_T	Total volume occupied by plume, ft^3, PV_T
80	15401.07	5,682,900

Discharge rate, Unit 1 ft^3/day, Q_1	Discharge rate, Unit 2 ft^3/day, Q_2	Discharge rate, Unit 3 ft^3/day, Q_3	Plume pore Vol., Unit 1 ft^3, PV_1	Plume pore Vol., Unit 2 ft^3, PV_2	Plume pore Vol., Unit 3 ft^3, PV_3	Time for 1 PV flush, Unit 1, days, t_1	Time for 1 PV flush, Unit 2, days, t_2	Time for 1 PV flush, Unit 3, days, t_3
11005.27	3391.69	1004.11	468839.25	483046.5	468839.25	42.60	142.42	466.92

Contaminant Half-Life Data

Does contaminant have a decay half-life (yes/no):	no	If yes, half-life (days):	365
1st order decay coefficient (k):	0.001899		

Average Pumped/Discharged and Residual Plume Concentrations Over Time

Target Cleanup Concentration :			10	ug/L
Time period	Time span, days, t	Avg pumped GW conc.	Avg residual GW conc.	Time span, years
0	0	0	**120**	0
2	85.20	109.119	**113.552**	0.23
3	127.80	104.124	**110.549**	0.35
4	170.41	99.404	**107.684**	0.47
6	255.61	90.723	**102.333**	0.70
8	340.81	82.961	**97.444**	0.93
10	426.01	76.014	**92.970**	1.17
14	596.42	64.214	**85.094**	1.63
18	766.82	54.711	**78.414**	2.10
24	1022.43	43.739	**70.143**	2.80
30	1278.04	35.666	**63.467**	3.50
36	1533.65	29.647	**57.972**	4.20
42	1789.26	25.092	**53.363**	4.90
50	2130.07	20.599	**48.243**	5.83
60	2556.08	16.654	**43.031**	7.00
70	2982.09	13.868	**38.754**	8.16
80	3408.11	11.804	**35.152**	9.33
100	4260.13	8.940	**29.369**	11.66
120	5112.16	7.028	**24.903**	14.00
160	6816.21	4.643	**18.460**	18.66
200	8520.27	3.259	**14.073**	23.33
220	9372.29	2.777	**12.378**	25.66
240	10224.32	2.389	**10.926**	27.99
250	10650.33	2.222	**10.277**	29.16
255	10863.34	2.145	**9.970**	29.74
254	10820.74	2.160	**10.030**	29.63

Adjust the initial time period to auto-adjust the following 19 time periods and obtain the desired range in concentrations.

The last 5 time periods can be modified to more precisely determine the time required to meet a specific residual concentration.

Project:	NWIRP Calverton	**Project No.:**	1610
Subject:	Engine Test House (Site 10B) Groundwater Extraction System FS Designs		
By:	JPO	**Date:**	10/4/2005
Checked:		**Date:**	

Project/Design Objective:

Design a groundwater extraction system for containment/cleanup of the source area for the chlorinated VOC/BTEX plume in the shallow groundwater flow system. Project cleanup rates/times assuming that the fuel calibration area source will be removed or otherwise isolated from groundwater. The final design should be capable of remediating contaminated groundwater to target cleanup levels within a reasonable time frame (30 years or less), and should offer significant advantages over natural processes in terms of cleanup rate and/or protection of receptors. This design should be considered as conceptual only - additional data, i.e., aquifer characteristics, contaminant distributions are needed for a final design.

Basis of Design Data: (Input cells yellow, blue automatically calculated)

Groundwater Plume Information

Plume Width (W):	150	ft.
Plume Thickness:	57	ft.
Plume Area:	25,200	ft^2
Volume of Groundwater in Plume:	359100	ft^3
Avg Hydraulic Conductivity, Plume Area:	100	ft/day

Aquifer Characteristics

Thickness (B):	57	ft.
Avg. Hydraulic Conductivity (K):	100	ft/day
Transmissivity (T):	5700	ft^2/day
Porosity (n):	0.25	
Storativity (S):	0.07	
Fractional Organic Carbon Content (foc):	0.001	
Flow Gradient (i):	0.0017	

Contaminant Characteristics

Contaminant A Representative gw conc.:	ethylbenzene	1084	ug/L
Contaminant B Representative gw conc.:	xylenes	196	
Koc, Contaminant A:		363	
Koc, Contaminant B:		407	
Kd, Contaminant A:		0.363	
Kd, Contaminant B:		0.407	
Half-life, Contaminant A:			years
Half-life, Contaminant B:			years
Target Cleanup Level, Contaminant A:		5	ug/L
Target Cleanup Level, Contaminant B:		5	ug/L

Remedial System Information

Extraction Well Radius, (r) :	0.25	ft.
Time to Reach Steady-State Drawdown (t):	30	days
Allowable Drawdown, Single Well, (s):	5	ft.

Technical Approach:

Using aquifer characteristics, plume volume, Kd, half-life, and representative groundwater concentration data, calculate the number of pore volume flushes and times required to reach the target groundwater concentration (performed using the attached spreadsheets). Use standard equations to calculate the minimum required pumping rate for plume containment, per-well achievable pumping rates, and well spacings. Develop a preliminary extraction system design based on the calculations, adjusting the design as appropriate based on data limitation considerations and best scientific judgement.

Minimum Required Total Pumping Rate (Qt)

Qt = TiW x 2 (2x the natural groundwater flow-thru rate for entire aquifer)

Qt = 1453.50 ft^3/day x 2, or 7.55 gpm x 2

Qt = 2907.00 ft^3/day, or 15.10 gpm

Maximum Achievable Pumping Rate in a Single Well (Qa)

Qa = $[4\pi Ts/2.3] / \log[2.25Tt/r^2S]$

Qa = 19600.98 ft^3/day, or 101.82 gpm

Minimum Number of Extraction Wells Required

= Qt/Qa

= 0.15 wells

Plume Cleanup Rate Projections (From Spreadsheet Program or Other Source)

At	15.1	gpm,	24.7	years
At	25.0	gpm,	14.9	years
At	40.0	gpm,	9.3	years
At natural GW flow rate: (plume area only)	7.55	gpm,	49.4	years

Contaminant that cleanup rate is based on: ethylbenzene

Based on the limiting conditions calculated above, projections regarding cleanup times at various pumping rates (see accompanying spreadsheets), a suitable safety factor based on the degree of confidence in the design data, and best scientific judgement, the following are the number of extraction wells and pumping rates selected for the design:

Number of Wells:	2		
Per-well Pumping Rate (Qw):	20	gpm, or	3850.20 ft^3/day
Total System Pumping Rate (Qes):	40	gpm, or	7700.40 ft^3/day

Extraction Well Spacings, (WSp), ft Perpendicular to Groundwater Flow Direction

WSp = $Qw/\pi Ti$, for a 2-well extraction system

WSp = 126.48 ft

or

WSp = $1.26(Qw)/\pi Ti$, for a 3-well extraction system

WSp = 159.36 ft

or

WSp = $1.2(Qw)/\pi Ti$, for an extraction system with 4+ wells

WSp = 151.77 ft

Downgradient Stagnation Point (SPd) Approximation

SPd = $Qes/2\pi Ti$, Qes = total extraction system pumping rate, ft^3/day

SPd = 126.48 ft

Alternate Layout of Extraction Well System (I.e., parallel to GW flow direction):

Space wells aligned along central axis of plume and within plume interior, biased towards hot spot location(s). Use 2 wells to provide flexibility to optimize placement in hot spot areas, have the capability to employ a cyclical pumping schedule, and provide maximum efficiency r.e. contaminant mass removal.

Final Configuration, Groundwater Extraction System:

Two 6-inch diameter extraction wells, screened from 10 to 60 feet below ground, installed within the plume interior along a line parallel to the groundwater flow direction. Each well will pump at an approximate rate of 20 gpm, with a projected cleanup time of approximately 9 years after the residual source is remediated. Co-contaminants (most notably xylenes, 1,1,2 trichlorotrifluoroethane) will also clean up within the given time frame (assuming no residual source). Reinject treated water through infiltration trenches located near the upgradient edge of the source area.

Heterogeneous Aquifer Flushing Rate Calculations

Project:	Claverton ET Area	Proj. No.:	1610
Chemical :	ethylbenzene	K_{OC} (K_d*) :	363
Concentration units, water & soil (pick 1):	mg/L & mg/Kg:	ug/L & ug/Kg:	x

NOTE: Input cells are shaded yellow; cells automatically calculated are shaded blue; the remaining cells are fixed.

All groundwater/soil contaminant concentrations are in consistent units, i.e., mg/L & mg/Kg, or ug/L & ug/Kg.

This spreadsheet calculates flushing rates and cleanup times for a groundwater flow system that consists of up to 3 groundwater "flow units". Flow units are discrete portions of the aquifer that have unique properties, i.e., higher or lower average hydraulic conductivity, porosity, or specific gravity relative to other portions of the aquifer, higher/lower contaminant concentrations, and/or different organic carbon contents. The spreadsheet factors in different flushing rates for discrete portions of the aquifer based on the differences in the physical/chemical characteristics of the flow units. First-order contaminant decay/degradation processes can also be factored into the cleanup rate prediction through the optional use of contaminant half-life data.

*** for contaminants that partition between soil and water thru mechanisms other than adsoption onto organic carbon, i.e., metals, the compound's K_d is input directly into the K_{OC} entry cell, with f_{OC} then set to 1. For fractured bedrock, reduce the f_{OC} by 1-2 orders of magnitude to adjust for typical low fracture porosity and resulting high model-perceived mass of aquifer sediments in contact with water.**

Groundwater Flow Unit Physical/Chemical Data

Flow Unit 1 (U1)		Flow Unit 2 (U2)		Flow Unit 3 (U3)	
Cw_{01}	1084.00	Cw_{02}	1084.00	Cw_{03}	1084.00
n	0.25	n	0.25	n	0.25
S_G	2.65	S_G	2.65	S_G	2.65
f_{OC}*	0.0010	f_{OC}*	0.0010	f_{OC}*	0.0010
K_d	0.363	K_d	0.363	K_d	0.363
M_W	271.000	M_W	271.000	M_W	271.000
C_S	393.492	C_S	393.492	C_S	393.492
M_S	782.065	M_S	782.065	M_S	782.065
M_T	1053.065	M_T	1053.065	M_T	1053.065
M_S/M_T	0.7427	M_S/M_T	0.7427	M_S/M_T	0.7427

Cw_{0N} = Initial contaminant concentration in groundwater flow unit N

Groundwater Flow Unit Hydrogeologic Characteristics

Avg. K, ft/d highest to lowest	Relative average K, K_U	Fraction of aquifer volume, FV_U	Fraction of total flow, FQ_U	Flow unit number, U
331	1.000	0.33	0.715	1
100	0.302	0.34	0.220	2
30.2	0.091	0.33	0.065	3

Pore Volumes and Pore Volume Removal Rates

Groundwater discharge rate, gpm	Groundwater discharge rate, ft^3/day, Q_T	Total volume occupied by plume, ft^3, PV_T
7.55	1453.48	1,436,400

Discharge rate, Unit 1 ft^3/day, Q_1	Discharge rate, Unit 2 ft^3/day, Q_2	Discharge rate, Unit 3 ft^3/day, Q_3	Plume pore Vol., Unit 1 ft^3, PV_1	Plume pore Vol., Unit 2 ft^3, PV_2	Plume pore Vol., Unit 3 ft^3, PV_3	Time for 1 PV flush, Unit 1, days, t_1	Time for 1 PV flush, Unit 2, days, t_2	Time for 1 PV flush, Unit 3, days, t_3
1038.62	320.09	94.76	118503	122094	118503	114.10	381.44	1250.53

Contaminant Half-Life Data

Does contaminant have a decay half-life (yes/no):	no	If yes, half-life (days):	365
1st order decay coefficient (k):	0.001899		

Average Pumped/Discharged and Residual Plume Concentrations Over Time

Target Cleanup Concentration :			5	ug/L
Time period	Time span, days, t	Avg pumped GW conc.	Avg residual GW conc.	Time span, years
0	0	0	1084	0
1	114.10	862.440	950.980	0.31
1.5	171.14	772.492	894.891	0.47
2	228.19	693.961	844.579	0.62
3	342.29	565.212	758.466	0.94
4	456.39	466.253	687.899	1.25
5	570.48	389.678	629.318	1.56
7	798.67	282.997	538.062	2.19
9	1026.87	215.748	470.211	2.81
12	1369.16	154.881	395.017	3.75
15	1711.44	118.792	339.191	4.69
18	2053.73	95.119	295.409	5.62
21	2396.02	78.297	259.846	6.56
25	2852.41	62.110	221.518	7.81
30	3422.89	47.940	184.016	9.37
35	3993.37	37.949	154.701	10.93
40	4563.85	30.657	131.261	12.50
50	5704.81	20.977	96.368	15.62
60	6845.78	15.010	71.945	18.74
80	9127.70	8.249	41.075	24.99
100	11409.63	4.714	23.744	31.24
120	13691.56	2.725	13.776	37.49
140	15973.48	1.581	8.001	43.73
150	17114.44	1.205	6.098	46.86
160	18255.41	0.918	4.648	49.98
158	18027.22	0.970	4.908	49.36

Adjust the initial time period to auto-adjust the following 19 time periods and obtain the desired range in concentrations.

The last 5 time periods can be modified to more precisely determine the time required to meet a specific residual concentration.

Heterogeneous Aquifer Flushing Rate Calculations

Project:	Claverton ET Area	Proj. No.:	1610
Chemical :	ethylbenzene	K_{OC} (K_d*) :	363
Concentration units, water & soil (pick 1):	mg/L & mg/Kg:	ug/L & ug/Kg:	x

NOTE: Input cells are shaded yellow; cells automatically calculated are shaded blue; the remaining cells are fixed.

All groundwater/soil contaminant concentrations are in consistent units, i.e., mg/L & mg/Kg, or ug/L & ug/Kg.

*** for contaminants that partition between soil and water thru mechanisms other than adsoption onto organic carbon, i.e., metals, the compound's K_d is input directly into the K_{OC} entry cell, with f_{OC} then set to 1. For fractured bedrock, reduce the f_{OC} by 1-2 orders of magnitude to adjust for typical low fracture porosity and resulting high model-perceived mass of aquifer sediments in contact with water.**

This spreadsheet calculates flushing rates and cleanup times for a groundwater flow system that consists of up to 3 groundwater "flow units". Flow units are discrete portions of the aquifer that have unique properties, i.e., higher or lower average hydraulic conductivity, porosity, or specific gravity relative to other portions of the aquifer, higher/lower contaminant concentrations, and/or different organic carbon contents. The spreadsheet factors in different flushing rates for discrete portions of the aquifer based on the differences in the physical/chemical characteristics of the flow units. First-order contaminant decay/degradation processes can also be factored into the cleanup rate prediction through the optional use of contaminant half-life data.

Groundwater Flow Unit Physical/Chemical Data

Flow Unit 1 (U1)		Flow Unit 2 (U2)		Flow Unit 3 (U3)	
Cw_{01}	1084.00	Cw_{02}	1084.00	Cw_{03}	1084.00
n	0.25	n	0.25	n	0.25
S_G	2.65	S_G	2.65	S_G	2.65
f_{OC}*	0.0010	f_{OC}*	0.0010	f_{OC}*	0.0010
K_d	0.363	K_d	0.363	K_d	0.363
M_W	271.000	M_W	271.000	M_W	271.000
C_S	393.492	C_S	393.492	C_S	393.492
M_S	782.065	M_S	782.065	M_S	782.065
M_T	1053.065	M_T	1053.065	M_T	1053.065
M_S/M_T	0.7427	M_S/M_T	0.7427	M_S/M_T	0.7427

Cw_{0N} = Initial contaminant concentration in groundwater flow unit N

Groundwater Flow Unit Hydrogeologic Characteristics

Avg. K, ft/d highest to lowest	Relative average K, K_U	Fraction of aquifer volume, FV_U	Fraction of total flow, FQ_U	Flow unit number, U
331	1.000	0.33	0.715	1
100	0.302	0.34	0.220	2
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Pore Volumes and Pore Volume Removal Rates

Groundwater discharge rate, gpm	Groundwater discharge rate, ft^3/day, Q_T	Total volume occupied by plume, ft^3, PV_T
15.1	2906.95	1,436,400

Discharge rate, Unit 1 ft^3/day, Q_1	Discharge rate, Unit 2 ft^3/day, Q_2	Discharge rate, Unit 3 ft^3/day, Q_3	Plume pore Vol., Unit 1 ft^3, PV_1	Plume pore Vol., Unit 2 ft^3, PV_2	Plume pore Vol., Unit 3 ft^3, PV_3	Time for 1 PV flush, Unit 1, days, t_1	Time for 1 PV flush, Unit 2, days, t_2	Time for 1 PV flush, Unit 3, days, t_3
2077.25	640.18	189.53	118503	122094	118503	57.05	190.72	625.26

Contaminant Half-Life Data

Does contaminant have a decay half-life (yes/no):	no	If yes, half-life (days):	365
1st order decay coefficient (k):	0.001899		

Average Pumped/Discharged and Residual Plume Concentrations Over Time

Target Cleanup Concentration :		5	ug/L	
Time period	Time span, days, t	Avg pumped GW conc.	Avg residual GW conc.	Time span, years
0	0	0	**1084**	0
1	57.05	862.440	**950.980**	0.16
1.5	85.57	772.492	**894.891**	0.23
2	114.10	693.961	**844.579**	0.31
3	171.14	565.212	**758.466**	0.47
4	228.19	466.253	**687.899**	0.62
5	285.24	389.678	**629.318**	0.78
7	399.34	282.997	**538.062**	1.09
9	513.43	215.748	**470.211**	1.41
12	684.58	154.881	**395.017**	1.87
15	855.72	118.792	**339.191**	2.34
18	1026.87	95.119	**295.409**	2.81
21	1198.01	78.297	**259.846**	3.28
25	1426.20	62.110	**221.518**	3.90
30	1711.44	47.940	**184.016**	4.69
35	1996.69	37.949	**154.701**	5.47
40	2281.93	30.657	**131.261**	6.25
50	2852.41	20.977	**96.368**	7.81
60	3422.89	15.010	**71.945**	9.37
80	4563.85	8.249	**41.075**	12.50
100	5704.81	4.714	**23.744**	15.62
120	6845.78	2.725	**13.776**	18.74
140	7986.74	1.581	**8.001**	21.87
150	8557.22	1.205	**6.098**	23.43
160	9127.70	0.918	**4.648**	24.99
158	9013.61	0.970	**4.908**	24.68

Adjust the initial time period to auto-adjust the following 19 time periods and obtain the desired range in concentrations.

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Heterogeneous Aquifer Flushing Rate Calculations

Project:	Claverton ET Area	Proj. No.:	1610
Chemical :	ethylbenzene	K_{OC} (K_d*) :	363
Concentration units, water & soil (pick 1):	mg/L & mg/Kg:	ug/L & ug/Kg:	x

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This spreadsheet calculates flushing rates and cleanup times for a groundwater flow system that consists of up to 3 groundwater "flow units". Flow units are discrete portions of the aquifer that have unique properties, i.e., higher or lower average hydraulic conductivity, porosity, or specific gravity relative to other portions of the aquifer, higher/lower contaminant concentrations, and/or different organic carbon contents. The spreadsheet factors in different flushing rates for discrete portions of the aquifer based on the differences in the physical/chemical characteristics of the flow units. First-order contaminant decay/degradation processes can also be factored into the cleanup rate prediction through the optional use of contaminant half-life data.

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Groundwater Flow Unit Physical/Chemical Data

Flow Unit 1 (U1)		Flow Unit 2 (U2)		Flow Unit 3 (U3)	
Cw_{01}	1084.00	Cw_{02}	1084.00	Cw_{03}	1084.00
n	0.25	n	0.25	n	0.25
S_G	2.65	S_G	2.65	S_G	2.65
f_{OC}*	0.0010	f_{OC}*	0.0010	f_{OC}*	0.0010
K_d	0.363	K_d	0.363	K_d	0.363
M_W	271.000	M_W	271.000	M_W	271.000
C_S	393.492	C_S	393.492	C_S	393.492
M_S	782.065	M_S	782.065	M_S	782.065
M_T	1053.065	M_T	1053.065	M_T	1053.065
M_S/M_T	0.7427	M_S/M_T	0.7427	M_S/M_T	0.7427

Cw_{0N} = Initial contaminant concentration in groundwater flow unit N

Groundwater Flow Unit Hydrogeologic Characteristics

Avg. K, ft/d highest to lowest	Relative average K, K_U	Fraction of aquifer volume, FV_U	Fraction of total flow, FQ_U	Flow unit number, U
331	1.000	0.33	0.715	1
100	0.302	0.34	0.220	2
30.2	0.091	0.33	0.065	3

Pore Volumes and Pore Volume Removal Rates

Groundwater discharge rate, gpm	Groundwater discharge rate, ft^3/day, Q_T	Total volume occupied by plume, ft^3, PV_T
25	4812.83	1,436,400

Discharge rate, Unit 1 ft^3/day, Q_1	Discharge rate, Unit 2 ft^3/day, Q_2	Discharge rate, Unit 3 ft^3/day, Q_3	Plume pore Vol., Unit 1 ft^3, PV_1	Plume pore Vol., Unit 2 ft^3, PV_2	Plume pore Vol., Unit 3 ft^3, PV_3	Time for 1 PV flush, Unit 1, days, t_1	Time for 1 PV flush, Unit 2, days, t_2	Time for 1 PV flush, Unit 3, days, t_3
3439.15	1059.90	313.78	118503	122094	118503	34.46	115.19	377.66

Contaminant Half-Life Data

Does contaminant have a decay half-life (yes/no):	no	If yes, half-life (days):	365
1st order decay coefficient (k):	0.001899		

Average Pumped/Discharged and Residual Plume Concentrations Over Time

Target Cleanup Concentration :			5	ug/L
Time period	Time span, days, t	Avg pumped GW conc.	Avg residual GW conc.	Time span, years
0	0	0	1084	0
1	34.46	862.440	950.980	0.09
1.5	51.69	772.492	894.891	0.14
2	68.91	693.961	844.579	0.19
3	103.37	565.212	758.466	0.28
4	137.83	466.253	687.899	0.38
5	172.29	389.678	629.318	0.47
7	241.20	282.997	538.062	0.66
9	310.11	215.748	470.211	0.85
12	413.48	154.881	395.017	1.13
15	516.86	118.792	339.191	1.42
18	620.23	95.119	295.409	1.70
21	723.60	78.297	259.846	1.98
25	861.43	62.110	221.518	2.36
30	1033.71	47.940	184.016	2.83
35	1206.00	37.949	154.701	3.30
40	1378.28	30.657	131.261	3.77
50	1722.85	20.977	96.368	4.72
60	2067.42	15.010	71.945	5.66
80	2756.57	8.249	41.075	7.55
100	3445.71	4.714	23.744	9.43
120	4134.85	2.725	13.776	11.32
140	4823.99	1.581	8.001	13.21
150	5168.56	1.205	6.098	14.15
160	5513.13	0.918	4.648	15.09
158	5444.22	0.970	4.908	14.91

Adjust the initial time period to auto-adjust the following 19 time periods and obtain the desired range in concentrations.

The last 5 time periods can be modified to more precisely determine the time required to meet a specific residual concentration.

Heterogeneous Aquifer Flushing Rate Calculations

Project:	Claverton ET Area	Proj. No.:	1610
Chemical :	ethylbenzene	K_{OC} (K_d*) :	363
Concentration units, water & soil (pick 1):	mg/L & mg/Kg:	ug/L & ug/Kg:	x

NOTE: Input cells are shaded yellow; cells automatically calculated are shaded blue; the remaining cells are fixed.

All groundwater/soil contaminant concentrations are in consistent units, i.e., mg/L & mg/Kg, or ug/L & ug/Kg.

*** for contaminants that partition between soil and water thru mechanisms other than adsoption onto organic carbon, i.e., metals, the compound's K_d is input directly into the K_{OC} entry cell, with f_{OC} then set to 1. For fractured bedrock, reduce the f_{OC} by 1-2 orders of magnitude to adjust for typical low fracture porosity and resulting high model-perceived mass of aquifer sediments in contact with water.**

This spreadsheet calculates flushing rates and cleanup times for a groundwater flow system that consists of up to 3 groundwater "flow units". Flow units are discrete portions of the aquifer that have unique properties, i.e., higher or lower average hydraulic conductivity, porosity, or specific gravity relative to other portions of the aquifer, higher/lower contaminant concentrations, and/or different organic carbon contents. The spreadsheet factors in different flushing rates for discrete portions of the aquifer based on the differences in the physical/chemical characteristics of the flow units. First-order contaminant decay/degradation processes can also be factored into the cleanup rate prediction through the optional use of contaminant half-life data.

Groundwater Flow Unit Physical/Chemical Data

Flow Unit 1 (U1)		Flow Unit 2 (U2)		Flow Unit 3 (U3)	
Cw_{01}	1084.00	Cw_{02}	1084.00	Cw_{03}	1084.00
n	0.25	n	0.25	n	0.25
S_G	2.65	S_G	2.65	S_G	2.65
f_{OC}*	0.0010	f_{OC}*	0.0010	f_{OC}*	0.0010
K_d	0.363	K_d	0.363	K_d	0.363
M_W	271.000	M_W	271.000	M_W	271.000
C_S	393.492	C_S	393.492	C_S	393.492
M_S	782.065	M_S	782.065	M_S	782.065
M_T	1053.065	M_T	1053.065	M_T	1053.065
M_S/M_T	0.7427	M_S/M_T	0.7427	M_S/M_T	0.7427

Cw_{0N} = Initial contaminant concentration in groundwater flow unit N

Groundwater Flow Unit Hydrogeologic Characteristics

Avg. K, ft/d highest to lowest	Relative average K, K_U	Fraction of aquifer volume, FV_U	Fraction of total flow, FQ_U	Flow unit number, U
331	1.000	0.33	0.715	1
100	0.302	0.34	0.220	2
30.2	0.091	0.33	0.065	3

Pore Volumes and Pore Volume Removal Rates

Groundwater discharge rate, gpm	Groundwater discharge rate, ft^3/day, Q_T	Total volume occupied by plume, ft^3, PV_T
35	6737.97	1,436,400

Discharge rate, Unit 1 ft^3/day, Q_1	Discharge rate, Unit 2 ft^3/day, Q_2	Discharge rate, Unit 3 ft^3/day, Q_3	Plume pore Vol., Unit 1 ft^3, PV_1	Plume pore Vol., Unit 2 ft^3, PV_2	Plume pore Vol., Unit 3 ft^3, PV_3	Time for 1 PV flush, Unit 1, days, t_1	Time for 1 PV flush, Unit 2, days, t_2	Time for 1 PV flush, Unit 3, days, t_3
4814.81	1483.86	439.30	118503	122094	118503	24.61	82.28	269.76

Contaminant Half-Life Data

Does contaminant have a decay half-life (yes/no):	no	If yes, half-life (days):	365
1st order decay coefficient (k):	0.001899		

Average Pumped/Discharged and Residual Plume Concentrations Over Time

Target Cleanup Concentration :		5	ug/L	
Time period	Time span, days, t	Avg pumped GW conc.	Avg residual GW conc.	Time span, years
0	0	0	1084	0
1	24.61	862.440	950.980	0.07
1.5	36.92	772.492	894.891	0.10
2	49.22	693.961	844.579	0.13
3	73.84	565.212	758.466	0.20
4	98.45	466.253	687.899	0.27
5	123.06	389.678	629.318	0.34
7	172.29	282.997	538.062	0.47
9	221.51	215.748	470.211	0.61
12	295.35	154.881	395.017	0.81
15	369.18	118.792	339.191	1.01
18	443.02	95.119	295.409	1.21
21	516.86	78.297	259.846	1.42
25	615.31	62.110	221.518	1.68
30	738.37	47.940	184.016	2.02
35	861.43	37.949	154.701	2.36
40	984.49	30.657	131.261	2.70
50	1230.61	20.977	96.368	3.37
60	1476.73	15.010	71.945	4.04
80	1968.98	8.249	41.075	5.39
100	2461.22	4.714	23.744	6.74
120	2953.46	2.725	13.776	8.09
140	3445.71	1.581	8.001	9.43
150	3691.83	1.205	6.098	10.11
160	3937.95	0.918	4.648	10.78
158	3888.73	0.970	4.908	10.65

Adjust the initial time period to auto-adjust the following 19 time periods and obtain the desired range in concentrations.

The last 5 time periods can be modified to more precisely determine the time required to meet a specific residual concentration.

Heterogeneous Aquifer Flushing Rate Calculations

Project:	Claverton ET Area	Proj. No.:	1610
Chemical :	ethylbenzene	K_{OC} (K_d*) :	363
Concentration units, water & soil (pick 1):	mg/L & mg/Kg:	ug/L & ug/Kg:	x

NOTE: Input cells are shaded yellow; cells automatically calculated are shaded blue; the remaining cells are fixed.

All groundwater/soil contaminant concentrations are in consistent units, i.e., mg/L & mg/Kg, or ug/L & ug/Kg.

*** for contaminants that partition between soil and water thru mechanisms other than adsoption onto organic carbon, i.e., metals, the compound's K_d is input directly into the K_{OC} entry cell, with f_{OC} then set to 1. For fractured bedrock, reduce the f_{OC} by 1-2 orders of magnitude to adjust for typical low fracture porosity and resulting high model-perceived mass of aquifer sediments in contact with water.**

This spreadsheet calculates flushing rates and cleanup times for a groundwater flow system that consists of up to 3 groundwater "flow units". Flow units are discrete portions of the aquifer that have unique properties, i.e., higher or lower average hydraulic conductivity, porosity, or specific gravity relative to other portions of the aquifer, higher/lower contaminant concentrations, and/or different organic carbon contents. The spreadsheet factors in different flushing rates for discrete portions of the aquifer based on the differences in the physical/chemical characteristics of the flow units. First-order contaminant decay/degradation processes can also be factored into the cleanup rate prediction through the optional use of contaminant half-life data.

Groundwater Flow Unit Physical/Chemical Data

Flow Unit 1 (U1)		Flow Unit 2 (U2)		Flow Unit 3 (U3)	
Cw_{01}	1084.00	Cw_{02}	1084.00	Cw_{03}	1084.00
n	0.25	n	0.25	n	0.25
S_G	2.65	S_G	2.65	S_G	2.65
f_{OC}*	0.0010	f_{OC}*	0.0010	f_{OC}*	0.0010
K_d	0.363	K_d	0.363	K_d	0.363
M_W	271.000	M_W	271.000	M_W	271.000
C_S	393.492	C_S	393.492	C_S	393.492
M_S	782.065	M_S	782.065	M_S	782.065
M_T	1053.065	M_T	1053.065	M_T	1053.065
M_S/M_T	0.7427	M_S/M_T	0.7427	M_S/M_T	0.7427

Cw_{0N} = Initial contaminant concentration in groundwater flow unit N

Groundwater Flow Unit Hydrogeologic Characteristics

Avg. K, ft/d highest to lowest	Relative average K, K_U	Fraction of aquifer volume, FV_U	Fraction of total flow, FQ_U	Flow unit number, U
331	1.000	0.33	0.715	1
100	0.302	0.34	0.220	2
30.2	0.091	0.33	0.065	3

Pore Volumes and Pore Volume Removal Rates

Groundwater discharge rate, gpm	Groundwater discharge rate, ft^3/day, Q_T	Total volume occupied by plume, ft^3, PV_T
40	7700.53	1,436,400

Discharge rate, Unit 1 ft^3/day, Q_1	Discharge rate, Unit 2 ft^3/day, Q_2	Discharge rate, Unit 3 ft^3/day, Q_3	Plume pore Vol., Unit 1 ft^3, PV_1	Plume pore Vol., Unit 2 ft^3, PV_2	Plume pore Vol., Unit 3 ft^3, PV_3	Time for 1 PV flush, Unit 1, days, t_1	Time for 1 PV flush, Unit 2, days, t_2	Time for 1 PV flush, Unit 3, days, t_3
5502.64	1695.84	502.05	118503	122094	118503	21.54	72.00	236.04

Contaminant Half-Life Data

Does contaminant have a decay half-life (yes/no):	no	If yes, half-life (days):	365
1st order decay coefficient (k):	0.001899		

Average Pumped/Discharged and Residual Plume Concentrations Over Time

Target Cleanup Concentration :		5	ug/L	
Time period	Time span, days, t	Avg pumped GW conc.	Avg residual GW conc.	Time span, years
0	0	0	**1084**	0
1	21.54	862.440	**950.980**	0.06
1.5	32.30	772.492	**894.891**	0.09
2	43.07	693.961	**844.579**	0.12
3	64.61	565.212	**758.466**	0.18
4	86.14	466.253	**687.899**	0.24
5	107.68	389.678	**629.318**	0.29
7	150.75	282.997	**538.062**	0.41
9	193.82	215.748	**470.211**	0.53
12	258.43	154.881	**395.017**	0.71
15	323.04	118.792	**339.191**	0.88
18	387.64	95.119	**295.409**	1.06
21	452.25	78.297	**259.846**	1.24
25	538.39	62.110	**221.518**	1.47
30	646.07	47.940	**184.016**	1.77
35	753.75	37.949	**154.701**	2.06
40	861.43	30.657	**131.261**	2.36
50	1076.78	20.977	**96.368**	2.95
60	1292.14	15.010	**71.945**	3.54
80	1722.85	8.249	**41.075**	4.72
100	2153.57	4.714	**23.744**	5.90
120	2584.28	2.725	**13.776**	7.08
140	3014.99	1.581	**8.001**	8.25
150	3230.35	1.205	**6.098**	8.84
160	3445.71	0.918	**4.648**	9.43
158	3402.64	0.970	**4.908**	9.32

Adjust the initial time period to auto-adjust the following 19 time periods and obtain the desired range in concentrations.

The last 5 time periods can be modified to more precisely determine the time required to meet a specific residual concentration.

Project:	**NWIRP Calverton**	**Project No.:**	**1610**
Subject:	**Downgradient Plume Groundwater Extraction System FS Designs**		
By:	JPO	**Date:**	10/4/2005
Checked:		**Date:**	

Project/Design Objective:

Design a groundwater extraction system for containment/cleanup of the onbase downgradient chlorinated VOC/BTEX plume in the shallow groundwater flow system. Project cleanup rates/times assuming that the contaminant sources and hot spots will be removed or otherwise contained. The final design should be capable of remediating contaminated groundwater to target cleanup levels within a reasonable time frame (30 years or less), and should offer significant advantages over natural processes in terms of cleanup rate and/or protection of receptors. This design should be considered as conceptual only - additional data, i.e., aquifer characteristics, contaminant distributions are needed for a final design.

Basis of Design Data: (Input cells yellow, blue automatically calculated)

Groundwater Plume Information

Plume Width (W):	2000	ft.
Plume Thickness:	60	ft.
Plume Area:	8,000,000	ft^2
Volume of Groundwater in Plume:	120000000	ft^3
Avg Hydraulic Conductivity, Plume Area:	100	ft/day

Aquifer Characteristics

Thickness (B):	60	ft.
Avg. Hydraulic Conductivity (K):	100	ft/day
Transmissivity (T):	6000	ft^2/day
Porosity (n):	0.25	
Storativity (S):	0.07	
Fractional Organic Carbon Content (foc):	0.001	
Flow Gradient (i):	0.0022	

Contaminant Characteristics

Contaminant A Representative gw conc.:	1,1-DCA	20	ug/L
Contaminant B Representative gw conc.:			
Koc, Contaminant A:		17	
Koc, Contaminant B:			
Kd, Contaminant A:		0.017	
Kd, Contaminant B:		0	
Half-life, Contaminant A:			years
Half-life, Contaminant B:			years
Target Cleanup Level, Contaminant A:		5	ug/L
Target Cleanup Level, Contaminant B:			ug/L

Remedial System Information

Extraction Well Radius, (r) :	0.25	ft.
Time to Reach Steady-State Drawdown (t):	30	days
Allowable Drawdown, Single Well, (s):	5	ft.

Technical Approach:

Using aquifer characteristics, plume volume, Kd, half-life, and representative groundwater concentration data, calculate the number of pore volume flushes and times required to reach the target groundwater concentration (performed using the attached spreadsheets). Use standard equations to calculate the minimum required pumping rate for plume containment, per-well achievable pumping rates, and well spacings. Develop a preliminary extraction system design based on the calculations, adjusting the design as appropriate based on data limitation considerations and best scientific judgement.

Required Pumping Rate (Qt) for Total Plume Capture

Qt = TiW x 2 (2x the natural groundwater flow-thru rate for entire aquifer)

Qt = 26400.00 ft^3/day x 2, or 137.14 gpm x 2

Qt = 52800.00 ft^3/day, or 274.27 gpm

Maximum Achievable Pumping Rate in a Single Well (Qa)

Qa = $[4\pi Ts/2.3] / \log [2.25Tt/r^2S]$

Qa = 20574.91 ft^3/day, or 106.88 gpm

Minimum Number of Extraction Wells Required

= Qt/Qa

= 2.57 wells

Plume Cleanup Rate Projections (From Spreadsheet Program or Other Source)

At	200.0	gpm,	11	years
At	250.0	gpm,	8.8	years
At	300.0	gpm,	7.4	years
At natural GW flow rate: (plume area only)	137.14	gpm,	16.1	years

Contaminant that cleanup rate is based on: 1,1-DCA

Based on the limiting conditions calculated above, projections regarding cleanup times at various pumping rates (see accompanying spreadsheets), a suitable safety factor based on the degree of confidence in the design data, and best scientific judgement, the following are the number of extraction wells and pumping rates selected for the design:

Number of Wells:	5			
Per-well Pumping Rate (Qw):	40	gpm, or	7700.40	ft^3/day
Total System Pumping Rate (Qes):	200	gpm, or	38502.00	ft^3/day

Extraction Well Spacings, (WSp), ft Perpendicular to Groundwater Flow Direction

WSp = $Qw/\pi Ti$, for a 2-well extraction system

WSp = 185.69 ft

or

WSp = $1.26(Qw)/\pi Ti$, for a 3-well extraction system

WSp = 233.97 ft

or

WSp = $1.2(Qw)/\pi Ti$, for an extraction system with 4+ wells

WSp = 222.83 ft

Downgradient Stagnation Point (SPd) Approximation

SPd = $Qes/2\pi Ti$, Qes = total extraction system pumping rate, ft^3/day

SPd = 464.22 ft

Alternate Layout of Extraction Well System (I.e., parallel to GW flow direction):

Space wells aligned along the downgradient boundary of the base, at an angle to the plume flow direction. Use 5 wells to provide flexibility to optimize pumping, have the capability to employ a cyclical pumping schedule, and provide maximum efficiency r.e. contaminant mass removal.

Final Configuration, Groundwater Extraction System:

Five 6-inch diameter extraction wells, screened from 10 to 60 feet below ground, installed along the downgradient base boundary. Each well will pump at an approximate rate of 40 gpm, with an assumed cleanup time of approximately 11 years after the residual source and groundwater hot spots are remediated. Reinject treated water through onbase infiltration trenches located outside of the lateral edges of the plume. Total plume capture not an objective since the plume has already migrated well beyond the site boundary.

Heterogeneous Aquifer Flushing Rate Calculations

Project:	Claverton Downgradient Area	Proj. No.:	1610
Chemical :	1,1 DCA	K_{OC} (K_d*) :	17
Concentration units, water & soil (pick 1):	mg/L & mg/Kg:	ug/L & ug/Kg:	x

NOTE: Input cells are shaded yellow; cells automatically calculated are shaded blue; the remaining cells are fixed.

This spreadsheet calculates flushing rates and cleanup times for a groundwater flow system that consists of up to 3 groundwater "flow units". Flow units are discrete portions of the aquifer that have unique properties, i.e., higher or lower average hydraulic conductivity, porosity, or specific gravity relative to other portions of the aquifer, higher/lower contaminant concentrations, and/or different organic carbon contents. The spreadsheet factors in different flushing rates for discrete portions of the aquifer based on the differences in the physical/chemical characteristics of the flow units. First-order contaminant decay/degradation processes can also be factored into the cleanup rate prediction through the optional use of contaminant half-life data.

All groundwater/soil contaminant concentrations are in consistent units, i.e., mg/L & mg/Kg, or ug/L & ug/Kg.

* for contaminants that partition between soil and water thru mechanisms other than adsoption onto organic carbon, i.e., metals, the compound's K_d is input directly into the K_{OC} entry cell, with f_{OC} then set to 1. For fractured bedrock, reduce the f_{OC} by 1-2 orders of magnitude to adjust for typical low fracture porosity and resulting high model-perceived mass of aquifer sediments in contact with water.

Groundwater Flow Unit Physical/Chemical Data

Flow Unit 1 (U1)		Flow Unit 2 (U2)		Flow Unit 3 (U3)	
Cw_{01}	20.00	Cw_{02}	20.00	Cw_{03}	20.00
n	0.25	n	0.25	n	0.25
S_G	2.65	S_G	2.65	S_G	2.65
f_{OC}*	0.0010	f_{OC}*	0.0010	f_{OC}*	0.0010
K_d	0.017	K_d	0.017	K_d	0.017
M_W	5.000	M_W	5.000	M_W	5.000
C_S	0.340	C_S	0.340	C_S	0.340
M_S	0.676	M_S	0.676	M_S	0.676
M_T	5.676	M_T	5.676	M_T	5.676
M_S/M_T	0.1191	M_S/M_T	0.1191	M_S/M_T	0.1191

Cw_{0N} = Initial contaminant concentration in groundwater flow unit N

Groundwater Flow Unit Hydrogeologic Characteristics

Avg. K, ft/d highest to lowest	Relative average K, K_U	Fraction of aquifer volume, FV_U	Fraction of total flow, FQ_U	Flow unit number, U
331	1.000	0.33	0.715	1
100	0.302	0.34	0.220	2
30.2	0.091	0.33	0.065	3

Pore Volumes and Pore Volume Removal Rates

Groundwater discharge rate, gpm	Groundwater discharge rate, ft^3/day, Q_T	Total volume occupied by plume, ft^3, PV_T
137	26374.33	480,000,000

Discharge rate, Unit 1 ft^3/day, Q_1	Discharge rate, Unit 2 ft^3/day, Q_2	Discharge rate, Unit 3 ft^3/day, Q_3	Plume pore Vol., Unit 1 ft^3, PV_1	Plume pore Vol., Unit 2 ft^3, PV_2	Plume pore Vol., Unit 3 ft^3, PV_3	Time for 1 PV flush, Unit 1, days, t_1	Time for 1 PV flush, Unit 2, days, t_2	Time for 1 PV flush, Unit 3, days, t_3
18846.53	5808.27	1719.53	39600000	40800000	39600000	2101.18	7024.47	23029.52

Contaminant Half-Life Data

Does contaminant have a decay half-life (yes/no):	no	If yes, half-life (days):	365
1st order decay coefficient (k):	0.001899		

Average Pumped/Discharged and Residual Plume Concentrations Over Time

Target Cleanup Concentration :			5	ug/L
Time period	Time span, days, t	Avg pumped GW conc.	Avg residual GW conc.	Time span, years
0	0	0	20	0
0.1	210.12	16.964	18.189	0.58
0.15	315.18	15.656	17.388	0.86
0.2	420.24	14.470	16.648	1.15
0.3	630.35	12.417	15.330	1.73
0.4	840.47	10.722	14.196	2.30
0.5	1050.59	9.318	13.213	2.88
0.7	1470.83	7.181	11.604	4.03
0.9	1891.06	5.684	10.348	5.18
1.2	2521.42	4.196	8.909	6.90
1.5	3151.77	3.257	7.821	8.63
1.8	3782.13	2.630	6.959	10.35
2.1	4412.48	2.188	6.252	12.08
2.5	5252.96	1.769	5.479	14.38
3	6303.55	1.405	4.704	17.26
3.5	7354.14	1.144	4.082	20.13
4	8404.73	0.948	3.570	23.01
5	10505.91	0.677	2.782	28.76
6	12607.10	0.503	2.208	34.52
8	16809.46	0.303	1.438	46.02
10	21011.83	0.195	0.959	57.53
2.6	5463.07	1.685	5.309	14.96
2.7	5673.19	1.607	5.147	15.53
2.8	5883.31	1.535	4.993	16.11
2.75	5778.25	1.570	5.069	15.82
2.9	6093.43	1.468	4.846	16.68

Adjust the initial time period to auto-adjust the following 19 time periods and obtain the desired range in concentrations.

The last 5 time periods can be modified to more precisely determine the time required to meet a specific residual concentration.

Heterogeneous Aquifer Flushing Rate Calculations

Project:	Claverton Downgradient Area	Proj. No.:	1610
Chemical :	1,1 DCA	K_{OC} (K_d*) :	17
Concentration units, water & soil (pick 1):	mg/L & mg/Kg:	ug/L & ug/Kg:	x

NOTE: Input cells are shaded yellow; cells automatically calculated are shaded blue; the remaining cells are fixed.

All groundwater/soil contaminant concentrations are in consistent units, i.e., mg/L & mg/Kg, or ug/L & ug/Kg.

* for contaminants that partition between soil and water thru mechanisms other than adsoption onto organic carbon, i.e., metals, the compound's K_d is input directly into the K_{OC} entry cell, with f_{OC} then set to 1. For fractured bedrock, reduce the f_{OC} by 1-2 orders of magnitude to adjust for typical low fracture porosity and resulting high model-perceived mass of aquifer sediments in contact with water.

This spreadsheet calculates flushing rates and cleanup times for a groundwater flow system that consists of up to 3 groundwater "flow units". Flow units are discrete portions of the aquifer that have unique properties, i.e., higher or lower average hydraulic conductivity, porosity, or specific gravity relative to other portions of the aquifer, higher/lower contaminant concentrations, and/or different organic carbon contents. The spreadsheet factors in different flushing rates for discrete portions of the aquifer based on the differences in the physical/chemical characteristics of the flow units. First-order contaminant decay/degradation processes can also be factored into the cleanup rate prediction through the optional use of contaminant half-life data.

Groundwater Flow Unit Physical/Chemical Data

Flow Unit 1 (U1)		Flow Unit 2 (U2)		Flow Unit 3 (U3)	
Cw_{01}	20.00	Cw_{02}	20.00	Cw_{03}	20.00
n	0.25	n	0.25	n	0.25
S_G	2.65	S_G	2.65	S_G	2.65
f_{OC}*	0.0010	f_{OC}*	0.0010	f_{OC}*	0.0010
K_d	0.017	K_d	0.017	K_d	0.017
M_W	5.000	M_W	5.000	M_W	5.000
C_S	0.340	C_S	0.340	C_S	0.340
M_S	0.676	M_S	0.676	M_S	0.676
M_T	5.676	M_T	5.676	M_T	5.676
M_S/M_T	0.1191	M_S/M_T	0.1191	M_S/M_T	0.1191

Cw_{0N} = Initial contaminant concentration in groundwater flow unit N

Groundwater Flow Unit Hydrogeologic Characteristics

Avg. K, ft/d highest to lowest	Relative average K, K_U	Fraction of aquifer volume, FV_U	Fraction of total flow, FQ_U	Flow unit number, U
331	1.000	0.33	0.715	1
100	0.302	0.34	0.220	2
30.2	0.091	0.33	0.065	3

Pore Volumes and Pore Volume Removal Rates

Groundwater discharge rate, gpm	Groundwater discharge rate, ft³/day, Q_T	Total volume occupied by plume, ft³, PV_T
200	38502.67	480,000,000

Discharge rate, Unit 1 ft³/day, Q_1	Discharge rate, Unit 2 ft³/day, Q_2	Discharge rate, Unit 3 ft³/day, Q_3	Plume pore Vol., Unit 1 ft³, PV_1	Plume pore Vol., Unit 2 ft³, PV_2	Plume pore Vol., Unit 3 ft³, PV_3	Time for 1 PV flush, Unit 1, days, t_1	Time for 1 PV flush, Unit 2, days, t_2	Time for 1 PV flush, Unit 3, days, t_3
27513.18	8479.22	2510.27	39600000	40800000	39600000	1439.31	4811.76	15775.22

Contaminant Half-Life Data

Does contaminant have a decay half-life (yes/no):	no	If yes, half-life (days):	365
1st order decay coefficient (k):	0.001899		

Average Pumped/Discharged and Residual Plume Concentrations Over Time

Target Cleanup Concentration :			5	ug/L
Time period	Time span, days, t	Avg pumped GW conc.	Avg residual GW conc.	Time span, years
0	0	0	20	0
0.1	143.93	16.964	18.189	0.39
0.15	215.90	15.656	17.388	0.59
0.2	287.86	14.470	16.648	0.79
0.3	431.79	12.417	15.330	1.18
0.4	575.72	10.722	14.196	1.58
0.5	719.66	9.318	13.213	1.97
0.7	1007.52	7.181	11.604	2.76
0.9	1295.38	5.684	10.348	3.55
1.2	1727.17	4.196	8.909	4.73
1.5	2158.97	3.257	7.821	5.91
1.8	2590.76	2.630	6.959	7.09
2.1	3022.55	2.188	6.252	8.28
2.5	3598.28	1.769	5.479	9.85
3	4317.93	1.405	4.704	11.82
3.5	5037.59	1.144	4.082	13.79
4	5757.24	0.948	3.570	15.76
5	7196.55	0.677	2.782	19.70
6	8635.86	0.503	2.208	23.64
8	11514.48	0.303	1.438	31.52
10	14393.10	0.195	0.959	39.41
2.6	3742.21	1.685	5.309	10.25
2.7	3886.14	1.607	5.147	10.64
2.8	4030.07	1.535	4.993	11.03
2.75	3958.10	1.570	5.069	10.84
2.9	4174.00	1.468	4.846	11.43

Adjust the initial time period to auto-adjust the following 19 time periods and obtain the desired range in concentrations.

The last 5 time periods can be modified to more precisely determine the time required to meet a specific residual concentration.

Heterogeneous Aquifer Flushing Rate Calculations

Project:	Claverton Downgradient Area	Proj. No.:	1610
Chemical :	1,1 DCA	K_{OC} (K_d*) :	17
Concentration units, water & soil (pick 1):	mg/L & mg/Kg:	ug/L & ug/Kg:	x

NOTE: Input cells are shaded yellow; cells automatically calculated are shaded blue; the remaining cells are fixed.

All groundwater/soil contaminant concentrations are in consistent units, i.e., mg/L & mg/Kg, or ug/L & ug/Kg.

This spreadsheet calculates flushing rates and cleanup times for a groundwater flow system that consists of up to 3 groundwater "flow units". Flow units are discrete portions of the aquifer that have unique properties, i.e., higher or lower average hydraulic conductivity, porosity, or specific gravity relative to other portions of the aquifer, higher/lower contaminant concentrations, and/or different organic carbon contents. The spreadsheet factors in different flushing rates for discrete portions of the aquifer based on the differences in the physical/chemical characteristics of the flow units. First-order contaminant decay/degradation processes can also be factored into the cleanup rate prediction through the optional use of contaminant half-life data.

*** for contaminants that partition between soil and water thru mechanisms other than adsoption onto organic carbon, i.e., metals, the compound's K_d is input directly into the K_{OC} entry cell, with f_{OC} then set to 1. For fractured bedrock, reduce the f_{OC} by 1-2 orders of magnitude to adjust for typical low fracture porosity and resulting high model-perceived mass of aquifer sediments in contact with water.**

Groundwater Flow Unit Physical/Chemical Data

Flow Unit 1 (U1)		Flow Unit 2 (U2)		Flow Unit 3 (U3)	
Cw_{01}	20.00	Cw_{02}	20.00	Cw_{03}	20.00
n	0.25	n	0.25	n	0.25
S_G	2.65	S_G	2.65	S_G	2.65
f_{OC}*	0.0010	f_{OC}*	0.0010	f_{OC}*	0.0010
K_d	0.017	K_d	0.017	K_d	0.017
M_W	5.000	M_W	5.000	M_W	5.000
C_S	0.340	C_S	0.340	C_S	0.340
M_S	0.676	M_S	0.676	M_S	0.676
M_T	5.676	M_T	5.676	M_T	5.676
M_S/M_T	0.1191	M_S/M_T	0.1191	M_S/M_T	0.1191

Cw_{0N} = Initial contaminant concentration in groundwater flow unit N

Groundwater Flow Unit Hydrogeologic Characteristics

Avg. K, ft/d highest to lowest	Relative average K, K_U	Fraction of aquifer volume, FV_U	Fraction of total flow, FQ_U	Flow unit number, U
331	1.000	0.33	0.715	1
100	0.302	0.34	0.220	2
30.2	0.091	0.33	0.065	3

Pore Volumes and Pore Volume Removal Rates

Groundwater discharge rate, gpm	Groundwater discharge rate, ft^3/day, Q_T	Total volume occupied by plume, ft^3, PV_T
250	48128.34	480,000,000

Discharge rate, Unit 1 ft^3/day, Q_1	Discharge rate, Unit 2 ft^3/day, Q_2	Discharge rate, Unit 3 ft^3/day, Q_3	Plume pore Vol., Unit 1 ft^3, PV_1	Plume pore Vol., Unit 2 ft^3, PV_2	Plume pore Vol., Unit 3 ft^3, PV_3	Time for 1 PV flush, Unit 1, days, t_1	Time for 1 PV flush, Unit 2, days, t_2	Time for 1 PV flush, Unit 3, days, t_3
34391.48	10599.03	3137.83	39600000	40800000	39600000	1151.45	3849.41	12620.18

Contaminant Half-Life Data

Does contaminant have a decay half-life (yes/no):	no	If yes, half-life (days):	365
1st order decay coefficient (k):	0.001899		

Average Pumped/Discharged and Residual Plume Concentrations Over Time

Target Cleanup Concentration :			5	ug/L
Time period	Time span, days, t	Avg pumped GW conc.	Avg residual GW conc.	Time span, years
0	0	0	20	0
0.1	115.14	16.964	18.189	0.32
0.15	172.72	15.656	17.388	0.47
0.2	230.29	14.470	16.648	0.63
0.3	345.43	12.417	15.330	0.95
0.4	460.58	10.722	14.196	1.26
0.5	575.72	9.318	13.213	1.58
0.7	806.01	7.181	11.604	2.21
0.9	1036.30	5.684	10.348	2.84
1.2	1381.74	4.196	8.909	3.78
1.5	1727.17	3.257	7.821	4.73
1.8	2072.61	2.630	6.959	5.67
2.1	2418.04	2.188	6.252	6.62
2.5	2878.62	1.769	5.479	7.88
3	3454.34	1.405	4.704	9.46
3.5	4030.07	1.144	4.082	11.03
4	4605.79	0.948	3.570	12.61
5	5757.24	0.677	2.782	15.76
6	6908.69	0.503	2.208	18.91
8	9211.58	0.303	1.438	25.22
10	11514.48	0.195	0.959	31.52
2.6	2993.76	1.685	5.309	8.20
2.7	3108.91	1.607	5.147	8.51
2.8	3224.05	1.535	4.993	8.83
2.75	3166.48	1.570	5.069	8.67
2.9	3339.20	1.468	4.846	9.14

Adjust the initial time period to auto-adjust the following 19 time periods and obtain the desired range in concentrations.

The last 5 time periods can be modified to more precisely determine the time required to meet a specific residual concentration.

Heterogeneous Aquifer Flushing Rate Calculations

Project:	Claverton Downgradient Area	Proj. No.:	1610
Chemical :	1,1 DCA	K_{OC} (K_d*) :	17
Concentration units, water & soil (pick 1):	mg/L & mg/Kg:	ug/L & ug/Kg:	x

NOTE: Input cells are shaded yellow; cells automatically calculated are shaded blue; the remaining cells are fixed.

All groundwater/soil contaminant concentrations are in consistent units, i.e., mg/L & mg/Kg, or ug/L & ug/Kg.

*** for contaminants that partition between soil and water thru mechanisms other than adsoption onto organic carbon, i.e., metals, the compound's K_d is input directly into the K_{OC} entry cell, with f_{OC} then set to 1. For fractured bedrock, reduce the f_{OC} by 1-2 orders of magnitude to adjust for typical low fracture porosity and resulting high model-perceived mass of aquifer sediments in contact with water.**

This spreadsheet calculates flushing rates and cleanup times for a groundwater flow system that consists of up to 3 groundwater "flow units". Flow units are discrete portions of the aquifer that have unique properties, i.e., higher or lower average hydraulic conductivity, porosity, or specific gravity relative to other portions of the aquifer, higher/lower contaminant concentrations, and/or different organic carbon contents. The spreadsheet factors in different flushing rates for discrete portions of the aquifer based on the differences in the physical/chemical characteristics of the flow units. First-order contaminant decay/degradation processes can also be factored into the cleanup rate prediction through the optional use of contaminant half-life data.

Groundwater Flow Unit Physical/Chemical Data

Flow Unit 1 (U1)		Flow Unit 2 (U2)		Flow Unit 3 (U3)	
Cw_{01}	20.00	Cw_{02}	20.00	Cw_{03}	20.00
n	0.25	n	0.25	n	0.25
S_G	2.65	S_G	2.65	S_G	2.65
f_{OC}*	0.0010	f_{OC}*	0.0010	f_{OC}*	0.0010
K_d	0.017	K_d	0.017	K_d	0.017
M_W	5.000	M_W	5.000	M_W	5.000
C_S	0.340	C_S	0.340	C_S	0.340
M_S	0.676	M_S	0.676	M_S	0.676
M_T	5.676	M_T	5.676	M_T	5.676
M_S/M_T	0.1191	M_S/M_T	0.1191	M_S/M_T	0.1191

Cw_{0N} = Initial contaminant concentration in groundwater flow unit N

Groundwater Flow Unit Hydrogeologic Characteristics

Avg. K, ft/d highest to lowest	Relative average K, K_U	Fraction of aquifer volume, FV_U	Fraction of total flow, FQ_U	Flow unit number, U
331	1.000	0.33	0.715	1
100	0.302	0.34	0.220	2
30.2	0.091	0.33	0.065	3

Pore Volumes and Pore Volume Removal Rates

Groundwater discharge rate, gpm	Groundwater discharge rate, ft³/day, Q_T	Total volume occupied by plume, ft³, PV_T
300	57754.01	480,000,000

Discharge rate, Unit 1 ft³/day, Q_1	Discharge rate, Unit 2 ft³/day, Q_2	Discharge rate, Unit 3 ft³/day, Q_3	Plume pore Vol., Unit 1 ft³, PV_1	Plume pore Vol., Unit 2 ft³, PV_2	Plume pore Vol., Unit 3 ft³, PV_3	Time for 1 PV flush, Unit 1, days, t_1	Time for 1 PV flush, Unit 2, days, t_2	Time for 1 PV flush, Unit 3, days, t_3
41269.77	12718.84	3765.40	39600000	40800000	39600000	959.54	3207.84	10516.81

Contaminant Half-Life Data

Does contaminant have a decay half-life (yes/no):	no	If yes, half-life (days):	365
1st order decay coefficient (k):	0.001899		

Average Pumped/Discharged and Residual Plume Concentrations Over Time

Target Cleanup Concentration :			5	ug/L
Time period	Time span, days, t	Avg pumped GW conc.	Avg residual GW conc.	Time span, years
0	0	0	**20**	0
0.1	95.95	16.964	**18.189**	0.26
0.15	143.93	15.656	**17.388**	0.39
0.2	191.91	14.470	**16.648**	0.53
0.3	287.86	12.417	**15.330**	0.79
0.4	383.82	10.722	**14.196**	1.05
0.5	479.77	9.318	**13.213**	1.31
0.7	671.68	7.181	**11.604**	1.84
0.9	863.59	5.684	**10.348**	2.36
1.2	1151.45	4.196	**8.909**	3.15
1.5	1439.31	3.257	**7.821**	3.94
1.8	1727.17	2.630	**6.959**	4.73
2.1	2015.03	2.188	**6.252**	5.52
2.5	2398.85	1.769	**5.479**	6.57
3	2878.62	1.405	**4.704**	7.88
3.5	3358.39	1.144	**4.082**	9.19
4	3838.16	0.948	**3.570**	10.51
5	4797.70	0.677	**2.782**	13.14
6	5757.24	0.503	**2.208**	15.76
8	7676.32	0.303	**1.438**	21.02
10	9595.40	0.195	**0.959**	26.27
2.6	2494.80	1.685	**5.309**	6.83
2.7	2590.76	1.607	**5.147**	7.09
2.8	2686.71	1.535	**4.993**	7.36
2.75	2638.74	1.570	**5.069**	7.22
2.9	2782.67	1.468	**4.846**	7.62

Adjust the initial time period to auto-adjust the following 19 time periods and obtain the desired range in concentrations.

The last 5 time periods can be modified to more precisely determine the time required to meet a specific residual concentration.

C.5-2 - TREATMENT SYSTEM

Tetra Tech NUS			*STANDARD CALCULATION SHEET*
CLIENT: Calverton, NY	FILE No: 1610 1110	BY: RFD 10/25/05	PAGE: 1 OF 11
SUBJECT: Calverton – Sites 6A, 10B, and Onsite Southern Area Groundwater Plume Alternative SAGW3 & OSAGP3 Groundwater Treatment		CHECKED BY: CAR 10/25/05	DATE: 10/10/05

1.0 TREATMENT SCHEME

These alternatives would consist of installing and operating three (3) "pump-and-treat" systems. Each of these systems would consist of a Groundwater Extraction Well System and an On-site Treatment System (oil-water separation [Site 6A only], suspended solid treatment as required, air stripping, and reinjection).

The treatment system schematic is shown in Figure B.4-1 and consists of the following unit operations/processes:

- Oil-water separator (needed for the Site 6A system)
- Equalization/precipitation, clarification, and/or filtration
- Air Stripping

Remedial action duration for groundwater system is provided in the attached calculations based on the extraction system design. For the purpose of this FS, it is assumed that 3 treatment systems will be used – 1 for Site 6A, 1 for Site 10B, and 1 for the Onsite Southern Area Groundwater Plume.

2.0 SITE 6A GROUNDWATER TREATMENT SYSTEM DESIGN

2.1 Extraction System

Based on groundwater extraction system design calculations, extraction wells are the following

Item\Site	Site 6A
Number of Extraction Wells	4
Screened Depth (ft bgs)	10 - 60
Location of Extraction Wells	Middle of Plume in a line from northwest corner to southeast corner
Extraction Rate per well (gpm)	20
Extraction Rate total (gpm)	80
Operation (years)	30

Calculations and figures for the extraction system design are attached.

2.2 Groundwater Extraction Pumps Design

Multi-stage submersible centrifugal pumps would be installed in the above wells as follows:

	Pump Design		
	Flow Rate (gpm)	**Total Discharge Head** (ft)	**Motor Size** (HP)
	20 per well	100	0.5
Total	80	---	---

Tetra Tech NUS		STANDARD CALCULATION SHEET	
CLIENT: Calverton, NY	FILE No: 1610 1110	BY: RFO 10/25/05	PAGE: 2 OF 11
SUBJECT: Calverton – Sites 6A, 10B, and Onsite Southern Area Groundwater Plume Alternative SAGW3 & OSAGP3 Groundwater Treatment		CHECKED BY: CAR 10/25/05	DATE: 10/10/05

2.3 Extracted Groundwater Quality

Based on the estimates of average concentrations of COCs, the anticipated quality of the groundwater extracted could be summarized as follows:

Parameter	Average of Positive Detections (ug/L)	New York State GW Quality Standard
1,1,1-Trichloroethane	12	5
1,1,2-Trichlorotrifluoroethane	1.1	5
1,1-Dichloroethane	15.3	5
1,1-Dichloroethene	1.3	5
1,2-Dichlorobenzene	0.58	3
2-Butanone	13	50
Acetone	6.2	50
Chloroethane	20	5
Ethylbenzene	1.1	5
Tetrachloroethene	0.23	5
Toluene	3.8	5
Total Xylenes	17	5

* Chemicals of concern that exceed the NY State GW standards are highlighted in black

2.4 Oil-Water Separator – Site 6a Only

Based upon an extraction rate of 80 gpm and information from Highland Tank (www.highlandtank.com), the smallest tank model that could be used at the site would be a Model R-HTC 1000. The nominal capacity of the Oil Water Separator is 1000 gallons.

2.5 On-Site Treatment Systems

2.5.1 Equalization

The Treatment System would feature an equalization tank to blend groundwater from various extraction wells. Equalization tank would be equipped with a mixer and would feature a closed-top design to control VOCs emission. Equalization tank would be vented to the inlet of the air stripper blower. Equalization tank would be sized to provide 30 minutes detention under design flow conditions.

Equalization Tank Volume: 80 gallons/minute x 30 minutes = 2,400 gallons

⇒ Call for a 7.5-foot diameter 8 feet high equalization tank with a working capacity of 2,500 gallons. Tank to be of cylindrical vertical configuration and manufactured of fiberglass or painted carbon steel. Tank to be of closed-top design with vent.

Mixer size @ 0.5 HP/1,000 gal: 2,500 gallons x 0.5 HP ÷ 1,000 gallons = 1.25 HP

⇒ Call for a top-mounted 1.25 HP low-speed turbine-type mixer.

Pumps would be provided to transfer groundwater from equalization tank to downstream treatment processes. Two transfer pumps should be provided, including an installed spare. Pump operation (start/stop) would be controlled by the liquid level in the equalization tank.

⇒ Call for two (one spare) horizontal-centrifugal 80 gpm equalized groundwater transfer pumps (100 ft design TDH – 2 HP motor).

2.5.2 Clarifier and/or Filtration (may not be required depending on Oil Water Separator & Equalization)

Clarifier – Used for settling and storage of particulates. Use design factor of 0.4 gpm/sf. Determine surface area of clarifier: 80 gpm ÷ 0.4 gpm/sf = 200 sf

⇒ Call for a 16-foot diameter 8 feet high equalization tank with a working capacity of 13,000 gallons. Tank to be of cylindrical vertical configuration and manufactured of fiberglass or painted carbon steel. Tank to be of closed-top design with vent.

Filtration - Use bag type filter unit to avoid liquid residual stream from backwashing. Size bag filter unit for replacement of filter bag element no more frequently than once a week.

Assuming approximately 10 mg/L TSS in untreated groundwater and 90% removal, TSS accumulation in the filter within a week would be:

80 gal/min x 1,440 min/day x 7 days/week x 8.34 lbs/gal x [(10 – 1) mg/l] x 10^{-6} = 60.5 lbs dry TSS /week

Assuming a typical solids capture capacity of approximately 1.0 lbs dry TSS per square foot of bag filter element, required surface of bag element is:

60.5 lbs ÷ 1.0 lbs/ft^2 = 60.5, say 60 ft^2

⇒ Call two (one spare) multi-bag pressurized filter unit with a total filter area of 60 ft^2

2.5.3 Air Stripping

Filtered groundwater would be treated in a low-profile multi-tray air stripper for the removal of most of the VOCs. According to the attached calculations sheet, the design of this air stripper may be summarized as follows:

Groundwater Flow:	80 gpm
Avg / Max VOCs In:	92 / 300 (assumed 3 time average) μg/L
VOCs Removal Efficiency:	98%
Air-to-Water Ratio:	56:1
No. of Stripper Trays:	3
Air Blower Flow:	600 cfm

Air-stripped groundwater would be pumped from the sump of the air stripper to the reinjection wells/trenches by one of two horizontal centrifugal pumps (one spare). Pump operation (start/stop) would be controlled by the liquid level in the air stripper sump.

⇒ Call for one low-profile multi-tray type air stripper North East Environmental Products ShallowTray Low Profile Air Stripper Model 2631 or equivalent with three (3) trays and a 600 cfm air blower.

⇒ Call for two (one spare) horizontal-centrifugal 80 gpm treated groundwater discharge pumps (100 ft design TDH - 2 HP motor).

Maximum quantity of VOCs in air stripper offgas:

(300 µg/L x 0.98) x 80 gpm x 1,440 min/day x 8.34 lbs/gal x 10^{-9} = 0.282, say 0.30 pounds per day

This is well below the deminimis level of 15 pounds per day; therefore, no offgas treatment system is required for the air stripper.

2.6 ESTIMATE QUANTITIES

Item	Site 6A
Extraction Wells - 60 ft deep, screened 10 to 60 ft	4
Extraction Wells Pumps	4 @ 20 gpm - 0.5 hp
Oil Water Separator	1000 gal Highland Tank Model R-HTC 1000
Equilization	7.5 ft diameter, 8 ft deep, 2500 gallon tank with 1.25 hp mixer and 2 - 80 gpm pumps (2 hp)
Clarifier (if needed)	16 ft diameter, 8 ft deep, 13000 gallon tank
Filtration (if needed)	2 multibag pressurized filters with total filter area of 60 sf
Air Stripper – ShallowTray low profile	NEEP Model 2631

Miscellaneous Items

Equipment control area/structure to protect the equipment from inclement weather and vandalism.
Control Panel and associated Process and Instrumentation Diagram (P&ID). Operation of the treatment will be controlled by a HAND-OFF-AUTO switch. In the AUTO position, which is the normal mode of operation, but its operation will be interlocked with pumps, high level switches, air stripper, etc. If the switches are tripped, the treatment system will shut down.

3.0 SITE 10B GROUNDWATER TREATMENT SYSTEM DESIGN

3.1 Extraction System

Based on groundwater extraction system design calculations, extraction wells are the following

Item\Site	Site 10B
Number of Extraction Wells	2
Screened Depth (ft bgs)	10 - 60
Location of Extraction Wells	Middle of Plume in a line from northwest corner to southeast corner
Extraction Rate per well (gpm)	20
Extraction Rate total (gpm)	40
Operation (years)	9

Calculations and figures for the extraction system design are attached.

3.2 Groundwater Extraction Pumps Design

Multi-stage submersible centrifugal pumps would be installed in the above wells as follows:

		Pump Design		
	Number Wells	**Flow Rate** (gpm)	**Total Discharge Head** (ft)	**Motor Size** (HP)
Site 10B	2	20	100	0.5
Total	2	40	---	---

3.3 Extracted Groundwater Quality

Based on the estimates of average concentrations of COCs for Site 10B, the anticipated quality of the groundwater extracted by the wells could be summarized as follows:

Parameter	Average of Positive Detections (ug/L)	New York State GW Quality Standard
1,1,1-Trichloroethane	32	5
1,1,2-Trichlorotrifluoroethane	91	5
1,1-Dichloroethane	21	5
1,1-Dichloroethene	37	5
Benzene	1.95	1
Bromodichloromethane	4.1	5
Bromomethane	353	5
Chlorobenzene	381	5
Chloroethane	91.45	5
Chloroform	15.25	7
Dichlorodifluoromethane	0.82	5
Ethylbenzene	262.76	5
Methylene Chloride	7	5
Toluene	141.15	5
Total Xylenes	103.5	5
Vinyl Chloride	59.8	2

* Chemicals of concern that exceed the NY State GW standards are highlighted in black

3.4 ON-SITE TREATMENT SYSTEMS

3.4.1 Equalization

Site 10B would feature an equalization tank to blend groundwater from the 2 extraction wells. Equalization tank would be equipped with a mixer and would feature a closed-top design to control VOCs emission. Equalization tank would be vented to the inlet of the air stripper blower. Equalization tank would be sized to provide 30 minutes detention under design flow conditions.

Equalization Tank Volume: 40 gallons/minute x 30 minutes = 1,200 gallons

⇒ Call for a 6-foot diameter 8 feet high equalization tank with a working capacity of 1,250 gallons. Tank to be of cylindrical vertical configuration and manufactured of fiberglass or painted carbon steel. Tank to be of closed-top design with vent.

Mixer size @ 0.5 HP/1,000 gal: 1,200 gallons x 0.5 HP ÷ 1,000 gallons = 0.6 HP

⇒ Call for a top-mounted 0.6 HP low-speed turbine-type mixer.

Pumps would be provided to transfer groundwater from equalization tank to downstream treatment processes. Two transfer pumps should be provided, including an installed spare. Pump operation (start/stop) would be controlled by the liquid level in the equalization tank.

⇒ Call for two (one spare) horizontal-centrifugal 40 gpm equalized groundwater transfer pumps (100 ft design TDH – 0.75 HP motor).

3.4.2 Clarifier and/or Filtration (may not be required depending on Equalization)

Clarifier – Used for settling and storage of particulates. Use design factor of 0.4 gpm/sf. Determine surface area of clarifier: 40 gpm ÷ 0.4 gpm/sf = 100 sf

⇒ Call for a 12-foot diameter 8 feet high equalization tank with a working capacity of 5,000 gallons. Tank to be of cylindrical vertical configuration and manufactured of fiberglass or painted carbon steel. Tank to be of closed-top design with vent.

Filtration - Use bag type filter unit to avoid liquid residual stream from backwashing. Size bag filter unit for replacement of filter bag element no more frequently than once a week.

Assuming approximately 10 mg/L TSS in untreated groundwater and 90% removal, TSS accumulation in the filter within a week would be:

40 gal/min x 1,440 min/day x 7 days/week x 8.34 lbs/gal x [(10 – 1) mg/l] x 10^{-6} = 30.3 lbs dry TSS /week

Assuming a typical solids capture capacity of approximately 1.0 lbs dry TSS per square foot of bag filter element, required surface of bag element is:

30.3 lbs ÷ 1.0 lbs/ft^2 = 30.3, say 30 ft^2

⇒ Call two (one spare) multi-bag pressurized filter unit with a total filter area of 30 ft^2

3.4.3 Air Stripping

Filtered groundwater would be treated in a low-profile multi-tray air stripper for the removal of most of the VOCs. According to the attached calculations sheet, the design of this air stripper may be summarized as follows:

Groundwater Flow:	40 gpm
Avg / Max VOCs In:	1600 / 4800 (assumed 3 time average) µg/L
VOCs Removal Efficiency:	98%
Air-to-Water Ratio:	56:1
No. of Stripper Trays:	4
Air Blower Flow:	300 cfm

Air-stripped groundwater would be pumped from the sump of the air stripper to the reinjection wells/trenches by one of two horizontal centrifugal pumps (one spare). Pump operation (start/stop) would be controlled by the liquid level in the air stripper sump.

⇒ Call for one low-profile multi-tray type air stripper North East Environmental Products ShallowTray Low Profile Air Stripper Model 2341 or equivalent with four (4) trays and 300 cfm air blower

⇒ Call for two (one spare) horizontal-centrifugal 40 gpm treated groundwater discharge pumps (100 ft design TDH - .075 HP motor).

Maximum quantity of VOCs in air stripper offgas:

(4800 μg/L x 0.98) x 40 gpm x 1,440 min/day x 8.34 lbs/gal x 10^{-9} = 2.26, say 2.5 pounds per day

This is well below the deminimis level of 15 pounds per day; therefore, no offgas treatment system is required for the air stripper.

3.5 ESTIMATE QUANTITIES

Item	Site 10B
Extraction Wells - 60 ft deep, screened 10 to 60 ft	2
Extraction Wells Pumps	2 @ 20 gpm - 0.5 hp
Equilization	6 ft diameter, 8 ft deep, 1250 gallon tank with 0.6 hp mixer and 2 - 40 gpm pumps (0.75 hp)
Clarifier (if needed)	12 ft diameter, 8 ft deep, 5000 gallon tank
Filtration (if needed)	2 multibag pressurized filters with total filter area of 30 sf
Air Stripper – ShallowTray low profile	NEEP Model 2341

Miscellaneous Items

Equipment control area/structure to protect the equipment from inclement weather and vandalism.
Control Panel and associated Process and Instrumentation Diagram (P&ID). Operation of the treatment will be controlled by a HAND-OFF-AUTO switch. In the AUTO position, which is the normal mode of operation, but its operation will be interlocked with pumps, high level switches, air stripper, etc. If the switches are tripped, the treatment system will shut down.

Tetra Tech NUS			*STANDARD CALCULATION SHEET*
CLIENT: Calverton, NY	FILE No: 1610 1110	BY: RFD 10/25/05	PAGE: 8 OF 11
SUBJECT: Calverton – Sites 6A, 10B, and Onsite Southern Area Groundwater Plume Alternative SAGW3 & OSAGP3 Groundwater Treatment		CHECKED BY: CAR 10/25/05	DATE: 10/10/05

4.0 ONSITE SOUTHERN AREA GROUNDWATER PLUME TREATMENT SYSTEM DESIGN

4.1 Extraction System

Based on groundwater extraction system design calculations, extraction wells are the following

Item\Site	Onsite Southern Area Groundwater Plume
Number of Extraction Wells	5
Screened Depth (ft bgs)	10 - 60
Location of Extraction Wells	Southern edge of property line to capture contamination
Extraction Rate per well (gpm)	40
Extraction Rate total (gpm)	200
Operation (years)	11

Calculations and figures for the extraction system design are attached.

4.2 Groundwater Extraction Pumps Design

Multi-stage submersible centrifugal pumps would be installed in the above wells as follows:

		Pump Design		
	Number Wells	**Flow Rate** (gpm)	**Total Discharge Head** (ft)	**Motor Size** (HP)
Onsite Southern Area Groundwater Plume	5	40	100	0.5
Total	5	200	---	---

4.3 Extracted Groundwater Quality

Based on the estimates of average concentrations of COCs for Site 10B (no groundwater quality data is available for the Onsite Southern Area Groundwater Plume), the anticipated quality of the groundwater extracted by System No. 2 could be summarized as follows:

Parameter	Average of Positive Detections (ug/L)	New York State GW Quality Standard
1,1,1-Trichloroethane	32	5
1,1,2-Trichlorotrifluoroethane	91	5
1,1-Dichloroethane	21	5
1,1-Dichloroethene	37	5
Benzene	1.95	1
Bromodichloromethane	4.1	5
Bromomethane	353	5
Chlorobenzene	381	5
Chloroethane	91.45	5
Chloroform	15.25	7
Dichlorodifluoromethane	0.82	5
Ethylbenzene	262.76	5

Parameter	Average of Positive Detections (ug/L)	New York State GW Quality Standard
Methylene Chloride	7	5
Toluene	141.15	5
Total Xylenes	103.5	5
Vinyl Chloride	59.8	2

* Chemicals of concern that exceed the NY State GW standards are highlighted in black

4.4 ON-SITE TREATMENT SYSTEMS

4.4.1 Equalization

The Treatment System would feature an equalization tank to blend groundwater from various extraction wells. Equalization tank would be equipped with a mixer and would feature a closed-top design to control VOCs emission. Equalization tank would be vented to the inlet of the air stripper blower. Equalization tank would be sized to provide 30 minutes detention under design flow conditions.

Equalization Tank Volume: 200 gallons/minute x 30 minutes = 6,000 gallons

⇒ Call for a 11-foot diameter 10 feet high equalization tank with a working capacity of 6,400 gallons. Tank to be of cylindrical vertical configuration and manufactured of fiberglass or painted carbon steel. Tank to be of closed-top design with vent.

Mixer size @ 0.5 HP/1,000 gal: 6,400 gallons x 0.5 HP ÷ 1,000 gallons = 3.2 HP

⇒ Call for a top-mounted 3.2 HP low-speed turbine-type mixer.

Pumps would be provided to transfer groundwater from equalization tank to downstream treatment processes. Two transfer pumps should be provided, including an installed spare. Pump operation (start/stop) would be controlled by the liquid level in the equalization tank.

⇒ Call for three (one spare) horizontal-centrifugal 100 gpm equalized groundwater transfer pumps (100 ft design TDH – 3 HP motor).

4.4.2 Clarifier and/or Filtration (may not be required depending on Equalization)

Clarifier – Used for settling and storage of particulates. Use design factor of 0.4 gpm/sf. Determine surface area of clarifier: 200 gpm ÷ 0.4 gpm/sf = 500 sf (for 2 units use 250 sf)

⇒ Call for two (2) 18-foot diameter 8 feet high equalization tank with a working capacity of 16,200 gallons. Tank to be of cylindrical vertical configuration and manufactured of fiberglass or painted carbon steel. Tank to be of closed-top design with vent.

Filtration - Use bag type filter unit to avoid liquid residual stream from backwashing. Size bag filter unit for replacement of filter bag element no more frequently than once a week.

Assuming approximately 10 mg/L TSS in untreated groundwater and 90% removal, TSS accumulation in the filter within a week would be:

200 gal/min x 1,440 min/day x 7 days/week x 8.34 lbs/gal x [(10 – 1) mg/l] x 10^{-6} = 151 lbs dry TSS /week

Assuming a typical solids capture capacity of approximately 1.0 lbs dry TSS per square foot of bag filter element, required surface of bag element is:

151 lbs ÷ 1.0 lbs/ft^2 = 151 ft^2

⇒ Call two (one spare) multi-bag pressurized filter unit with a total filter area of 151 ft^2

4.4.3 Air Stripping

Filtered groundwater would be treated in a low-profile multi-tray air stripper for the removal of most of the VOCs. According to the attached calculations sheet, the design of this air stripper may be summarized as follows:

For 1 Air Stripper	
Groundwater Flow:	200 gpm
Avg / Max VOCs In:	1600 / 4800 (assumed 3 time average) µg/L
VOCs Removal Efficiency:	98%
Air-to-Water Ratio:	67:1
No. of Stripper Trays:	4
Air Blower Flow:	1800 cfm

For 2 Air Strippers	
Groundwater Flow:	100 gpm
Avg / Max VOCs In:	1600 / 4800 (assumed 3 time average) µg/L
VOCs Removal Efficiency:	98%
Air-to-Water Ratio:	67:1
No. of Stripper Trays:	3
Air Blower Flow:	900 cfm

Air-stripped groundwater would be pumped from the sump of the air stripper to the reinjection wells/trenches by two of three horizontal centrifugal pumps (one spare). Pump operation (start/stop) would be controlled by the liquid level in the air stripper sump.

⇒ Call for one low-profile multi-tray type air stripper North East Environmental Products ShallowTray Low Profile Air Stripper Model 31231 or equivalent with three (3) trays and 1800 cfm air blower or two (2) low-profile multi-tray type air stripper North East Environmental Products ShallowTray Low Profile Air Stripper Model 3631 or equivalent with three (3) trays and 900 cfm air blower

⇒ Call for three (one spare) horizontal-centrifugal 100 gpm treated groundwater discharge pumps (100 ft design TDH - 3 HP motor).

Maximum quantity of VOCs and TRPH in air stripper offgas:

(4800 µg/L x 0.98) x 200 gpm x 1,440 min/day x 8.34 lbs/gal x 10^{-9} = 11.3, say 11.5 pounds per day

This is well below the deminimis level of 15 pounds per day; therefore, no offgas treatment system is required for the air stripper.

4.5 ESTIMATE QUANTITIES

Item	Onsite Southern Area Groundwater Plume
Extraction Wells - 60 ft deep, screened 10 to 60 ft	5
Extraction Wells Pumps	5 @ 40 gpm – 0.5 hp
Equilization	11 ft diameter, 10 ft deep, 6400 gallon tank with 3.2 hp mixer and 3 - 100 gpm pumps (3 hp)
Clarifier (if needed)	2 - 18 ft diameter, 8 ft deep, 16200 gallon tank
Filtration (if needed)	2 multibag pressurized filters with total filter area of 151 sf
Air Stripper – ShallowTray low profile	NEEP Model 31231 or 2 - NEEP Model 3631

Miscellaneous Items

Equipment control area/structure to protect the equipment from inclement weather and vandalism.
Control Panel and associated Process and Instrumentation Diagram (P&ID). Operation of the treatment will be controlled by a HAND-OFF-AUTO switch. In the AUTO position, which is the normal mode of operation, but its operation will be interlocked with pumps, high level switches, air stripper, etc. If the switches are tripped, the treatment system will shut down.

ShallowTray®
low profile air strippers

System Performance Estimate

Client and Proposal Information:

Navy Calverton
Site 6A Feasibility Study
1610 1110

Series chosen:	2600	
Water Flow Rate:	80 gpm	18.2 m3/hr
Air Flow Rate:	600 scfm	1020 m3/hr
Water Temp:	52 °F	11 °C
Air Temp:	50 °F	10 °C
A/W Ratio:	56 :1	
Safety Factor:	25%	

Contaminant	Untreated Influent / Effluent Target	SELECTED MODEL Model 2611 Effluent lbs/hr	ppmv / %removal	Model 2621 Effluent lbs/hr	ppmv / %removal	Model 2631 Effluent lbs/hr	ppmv / %removal	Model 2641 Effluent lbs/hr	ppmv / %removal	Model 2651 Effluent lbs/hr	ppmv / %removal
1,1,1-Trichloroethane	12 ppb	2 ppb		<1 ppb		<1 ppb		<1 ppb		<1 ppb	
Solubility 4,400 ppm	5 ppb	0.00	0.03	0.00	0.04	0.00	0.04	0.00	0.04	0.00	0.04
Mwt 133.41			83.65%		97.33%		99.56%		99.93%		99.99%
1,1- Dichloroethane	15.3 ppb	5 ppb		2 ppb		<1 ppb		<1 ppb		<1 ppb	
Solubility 5,500 ppm	5 ppb	0.00	0.04	0.00	0.06	0.00	0.06	0.00	0.06	0.00	0.07
Mwt 98.96			68.15%		89.85%		96.77%		98.97%		99.67%
Chloroethane	20 ppb	5 ppb		1 ppb		<1 ppb		<1 ppb		<1 ppb	
Solubility 5,740 ppm	5 ppb	0.00	0.10	0.00	0.12	0.00	0.13	0.00	0.13	0.00	0.13
Mwt 64.26			75.40%		93.95%		98.51%		99.63%		99.91%
Based on theoretical data only, CONSULT NEEP REPRESENTATIVE FOR WARRANTY											
Xylenes	17 ppb	5 ppb		1 ppb		<1 ppb		<1 ppb		<1 ppb	
Solubility 175 ppm	5 ppb	0.00	0.05	0.00	0.06	0.00	0.07	0.00	0.07	0.00	0.07
Mwt 106			72.53%		92.45%		97.93%		99.43%		99.84%
Total ppb	64 ppb	16 ppb		4 ppb		1 ppb		0 ppb		0 ppb	
Total VOC lbs/hr - ppmv		0.00	0.22	0.00	0.28	0.00	0.30	0.00	0.30	0.00	0.30
Total			74.46%		93.21%		98.14%		99.48%		99.85%

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Report Generated: 10/11/2005 | Modeler V6.12e 5/24/2001

ShallowTray®
low profile air strippers

System Performance Estimate

Client and Proposal Information:

Navy Calverton
Site 10B
Groundwater Plume
Feasibility Study - 1610 1110

Series chosen:	2300-P	
Water Flow Rate:	40 gpm	9.1 m3/hr
Air Flow Rate:	300 scfm	510 m3/hr
Water Temp:	52 °F	11 °C
Air Temp:	50 °F	10 °C
A/W Ratio:	56 :1	
Safety Factor:	25%	

Contaminant	Untreated Influent Effluent Target	Model P 2311 Effluent lbs/hr ppmv %removal	Model P 2321 Effluent lbs/hr ppmv %removal	Model P 2331 Effluent lbs/hr ppmv %removal	Model P 2341 Effluent lbs/hr ppmv %removal	SELECTED MODEL Model P 2351 Effluent lbs/hr ppmv %removal
1,1,1-Trichloroethane	32 ppb	5 ppb	<1 ppb	<1 ppb	<1 ppb	<1 ppb
Solubility 4,400 ppm	5 ppb	0.00 0.08	0.00 0.10	0.00 0.10	0.00 0.10	0.00 0.10
Mwt 133.41		83.65%	97.33%	99.56%	99.93%	99.99%
1,1,2-Trichloro-1,2,2-Trifluoroethane	91 ppb	5 ppb	<1 ppb	<1 ppb	<1 ppb	<1 ppb
Solubility 170 ppm	5 ppb	0.00 0.19	0.00 0.20	0.00 0.21	0.00 0.21	0.00 0.21
Mwt 187.38		94.15%	99.66%	99.98%	100.00%	100.00%
Based on theoretical data only, CONSULT NEEP REPRESENTATIVE FOR WARRANTY						
1,1- Dichloroethane	21 ppb	7 ppb	2 ppb	<1 ppb	<1 ppb	<1 ppb
Solubility 5,500 ppm	5 ppb	0.00 0.06	0.00 0.08	0.00 0.09	0.00 0.09	0.00 0.09
Mwt 98.96		68.15%	89.85%	96.77%	98.97%	99.67%
1,1-Dichloroethylene	37 ppb	4 ppb	<1 ppb	<1 ppb	<1 ppb	<1 ppb
Solubility 500 ppm	5 ppb	0.00 0.14	0.00 0.16	0.00 0.16	0.00 0.16	0.00 0.16
Mwt 96.94		88.94%	98.78%	99.86%	99.99%	100.00%
Benzene	1.95 ppb	<1 ppb	<1 ppb	<1 ppb	<1 ppb	<1 ppb
Solubility 1,780 ppm	1 ppb	0.00 0.01	0.00 0.01	0.00 0.01	0.00 0.01	0.00 0.01
Mwt 78.12		72.04%	92.18%	97.81%	99.39%	99.83%
Methylbromide	353 ppb	26 ppb	2 ppb	<1 ppb	<1 ppb	<1 ppb
Solubility 900 ppm	5 ppb	0.01 1.45	0.01 1.56	0.01 1.57	0.01 1.57	0.01 1.57
Mwt 95		92.57%	99.45%	99.96%	100.00%	100.00%
Based on theoretical data only, CONSULT NEEP REPRESENTATIVE FOR WARRANTY						
Chlorobenzene	381 ppb	142 ppb	53 ppb	20 ppb	7 ppb	3 ppb
Solubility 500 ppm	5 ppb	0.00 0.90	0.01 1.23	0.01 1.36	0.01 1.40	0.01 1.42
Mwt 112.56		62.69%	86.08%	94.81%	98.06%	99.28%
Chloroethane	91.45 ppb	22 ppb	6 ppb	1 ppb	<1 ppb	<1 ppb
Solubility 5,740 ppm	5 ppb	0.00 0.45	0.00 0.57	0.00 0.59	0.00 0.60	0.00 0.60
Mwt 64.26		75.40%	93.95%	98.51%	99.63%	99.91%
Based on theoretical data only, CONSULT NEEP REPRESENTATIVE FOR WARRANTY						
Ethyl Benzene	262.76 ppb	69 ppb	18 ppb	5 ppb	1 ppb	<1 ppb
Solubility 152 ppm	5 ppb	0.00 0.77	0.00 0.97	0.01 1.03	0.01 1.04	0.01 1.04
Mwt 106.16		73.84%	93.16%	98.21%	99.53%	99.88%
Toluene	141.15 ppb	43 ppb	13 ppb	4 ppb	1 ppb	<1 ppb
Solubility 515 ppm	5 ppb	0.00 0.45	0.00 0.59	0.00 0.63	0.00 0.64	0.00 0.65
Mwt 92.13		69.72%	90.83%	97.22%	99.16%	99.75%
Xylenes	103.5 ppb	28 ppb	8 ppb	2 ppb	<1 ppb	<1 ppb
Solubility 175 ppm	5 ppb	0.00 0.30	0.00 0.38	0.00 0.40	0.00 0.41	0.00 0.41
Mwt 106		72.53%	92.45%	97.93%	99.43%	99.84%
Vinyl Chloride	59.8 ppb	6 ppb	<1 ppb	<1 ppb	<1 ppb	<1 ppb
Solubility 1100 ppm	2 ppb	0.00 0.36	0.00 0.40	0.00 0.40	0.00 0.40	0.00 0.40
Mwt 62.5		89.13%	98.82%	99.87%	99.99%	100.00%
Total ppb	1576 ppb	359 ppb	104 ppb	33 ppb	11 ppb	4 ppb
Total VOC lbs/hr - ppmv		0.02 5.18	0.03 6.26	0.03 6.55	0.03 6.64	0.03 6.67
Total		77.21%	93.41%	97.90%	99.30%	99.76%

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ShallowTray®
low profile air strippers

System Performance Estimate

Client and Proposal Information:

Navy Calverton
Onsite Southern Area Groundwater Plume
Groundwater Plume
Feasibility Study - 1610 1110

Series chosen:	31200	
Water Flow Rate:	200 gpm	45.4 m3/hr
Air Flow Rate:	1800 scfm	3060 m3/hr
Water Temp:	52 °F	11 °C
Air Temp:	50 °F	10 °C
A/W Ratio:	67 :1	
Safety Factor:	25%	

Contaminant	Untreated Influent / Effluent Target	Model 31211 Effluent (lbs/hr ppmv, %removal)	Model 31221 Effluent (lbs/hr ppmv, %removal)	Model 31231 Effluent (lbs/hr ppmv, %removal)	Model 31241 Effluent (lbs/hr ppmv, %removal)	SELECTED MODEL Model 31251 Effluent (lbs/hr ppmv, %removal)
1,1,1-Trichloroethane	32 ppb	4 ppb	<1 ppb	<1 ppb	<1 ppb	<1 ppb
Solubility 4,400 ppm	5 ppb	0.00 0.07	0.00 0.08	0.00 0.08	0.00 0.08	0.00 0.08
Mwt 133.41		87.89%	98.53%	99.82%	99.98%	100.00%
1,1,2-Trichloro-1,2,2-Trifluoroethane	91 ppb	3 ppb	<1 ppb	<1 ppb	<1 ppb	<1 ppb
Solubility 170 ppm	5 ppb	0.01 0.17	0.01 0.17	0.01 0.17	0.01 0.17	0.01 0.17
Mwt 187.38		96.92%	99.90%	100.00%	100.00%	100.00%
Based on theoretical data only, CONSULT NEEP REPRESENTATIVE FOR WARRANTY						
1,1- Dichloroethane	21 ppb	5 ppb	1 ppb	<1 ppb	<1 ppb	<1 ppb
Solubility 5,500 ppm	5 ppb	0.00 0.06	0.00 0.07	0.00 0.07	0.00 0.07	0.00 0.07
Mwt 98.96		75.84%	94.17%	98.59%	99.66%	99.92%
1,1-Dichloroethylene	37 ppb	3 ppb	<1 ppb	<1 ppb	<1 ppb	<1 ppb
Solubility 500 ppm	5 ppb	0.00 0.12	0.00 0.13	0.00 0.13	0.00 0.13	0.00 0.13
Mwt 96.94		91.93%	99.35%	99.95%	100.00%	100.00%
Benzene	1.95 ppb	<1 ppb	<1 ppb	<1 ppb	<1 ppb	<1 ppb
Solubility 1,780 ppm	1 ppb	0.00 0.01	0.00 0.01	0.00 0.01	0.00 0.01	0.00 0.01
Mwt 78.12		75.14%	93.82%	98.46%	99.62%	99.91%
Methylbromide	353 ppb	15 ppb	<1 ppb	<1 ppb	<1 ppb	<1 ppb
Solubility 900 ppm	5 ppb	0.03 1.25	0.04 1.31	0.04 1.31	0.04 1.31	0.04 1.31
Mwt 95		95.88%	99.83%	99.99%	100.00%	100.00%
Based on theoretical data only, CONSULT NEEP REPRESENTATIVE FOR WARRANTY						
Chlorobenzene	381 ppb	129 ppb	44 ppb	15 ppb	5 ppb	2 ppb
Solubility 500 ppm	5 ppb	0.03 0.79	0.03 1.06	0.04 1.15	0.04 1.18	0.04 1.19
Mwt 112.56		66.07%	88.49%	96.09%	98.67%	99.55%
Chloroethane	91.45 ppb	20 ppb	4 ppb	<1 ppb	<1 ppb	<1 ppb
Solubility 5,740 ppm	5 ppb	0.01 0.39	0.01 0.48	0.01 0.50	0.01 0.50	0.01 0.50
Mwt 64.26		78.20%	95.25%	98.96%	99.77%	99.95%
Based on theoretical data only, CONSULT NEEP REPRESENTATIVE FOR WARRANTY						
Ethyl Benzene	262.76 ppb	61 ppb	14 ppb	3 ppb	<1 ppb	<1 ppb
Solubility 152 ppm	5 ppb	0.02 0.67	0.02 0.83	0.03 0.86	0.03 0.87	0.03 0.87
Mwt 106.16		76.87%	94.65%	98.76%	99.71%	99.93%
Toluene	141.15 ppb	38 ppb	10 ppb	3 ppb	<1 ppb	<1 ppb
Solubility 515 ppm	5 ppb	0.01 0.39	0.01 0.50	0.01 0.53	0.01 0.54	0.01 0.54
Mwt 92.13		72.91%	92.66%	98.01%	99.46%	99.85%
Xylenes	103.5 ppb	25 ppb	6 ppb	2 ppb	<1 ppb	<1 ppb
Solubility 175 ppm	5 ppb	0.01 0.26	0.01 0.32	0.01 0.34	0.01 0.34	0.01 0.34
Mwt 106		75.61%	94.05%	98.55%	99.65%	99.91%
Vinyl Chloride	59.8 ppb	4 ppb	<1 ppb	<1 ppb	<1 ppb	<1 ppb
Solubility 1100 ppm	2 ppb	0.01 0.32	0.01 0.34	0.01 0.34	0.01 0.34	0.01 0.34
Mwt 62.5		93.48%	99.57%	99.97%	100.00%	100.00%
Total ppb	1576 ppb	307 ppb	82 ppb	24 ppb	7 ppb	2 ppb
Total VOC lbs/hr - ppmv		0.13 4.50	0.15 5.29	0.16 5.49	0.16 5.54	0.16 5.56
Total		80.51%	94.81%	98.49%	99.54%	99.86%

Report Generated: 10/25/2005 Modeler V6.12e 5/24/2001

ShallowTray®
low profile air strippers

System Performance Estimate

Client and Proposal Information:

Navy Calverton
Onsite Southern Area Groundwater Plume
Groundwater Plume
Feasibility Study - 1610 1110

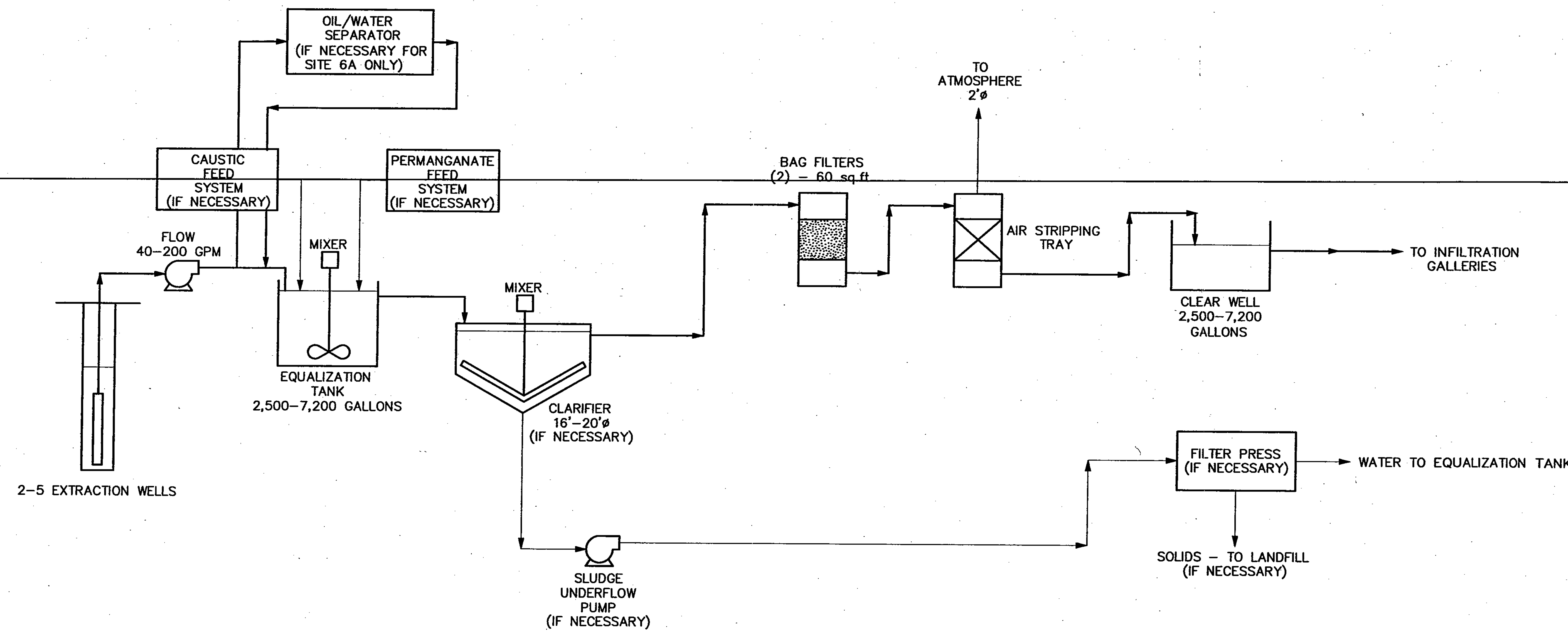
Series chosen:	3600	
Water Flow Rate:	100 gpm	22.7 m3/hr
Air Flow Rate:	900 scfm	1530 m3/hr
Water Temp:	52 °F	11 °C
Air Temp:	50 °F	10 °C
A/W Ratio:	67 :1	
Safety Factor:	25%	

Contaminant	Untreated Influent Effluent Target	Model 3611 Effluent lbs/hr	ppmv	Model 3621 Effluent lbs/hr	ppmv	Model 3631 Effluent lbs/hr	ppmv	Model 3641 Effluent lbs/hr	ppmv	SELECTED MODEL Model 3651 Effluent lbs/hr	ppmv
		%removal		%removal		%removal		%removal		%removal	
1,1,1-Trichloroethane	32 ppb	4 ppb		<1 ppb		<1 ppb		<1 ppb		<1 ppb	
Solubility 4,400 ppm	5 ppb	0.00	0.07	0.00	0.08	0.00	0.08	0.00	0.08	0.00	0.08
Mwt 133.41		87.89%		98.53%		99.82%		99.98%		100.00%	
1,1,2-Trichloro-1,2,2-Trifluoroethane	91 ppb	3 ppb		<1 ppb		<1 ppb		<1 ppb		<1 ppb	
Solubility 170 ppm	5 ppb	0.00	0.17	0.00	0.17	0.00	0.17	0.00	0.17	0.00	0.17
Mwt 187.38		96.92%		99.90%		100.00%		100.00%		100.00%	
Based on theoretical data only, CONSULT NEEP REPRESENTATIVE FOR WARRANTY											
1,1- Dichloroethane	21 ppb	5 ppb		1 ppb		<1 ppb		<1 ppb		<1 ppb	
Solubility 5,500 ppm	5 ppb	0.00	0.06	0.00	0.07	0.00	0.07	0.00	0.07	0.00	0.07
Mwt 98.96		75.84%		94.17%		98.59%		99.66%		99.92%	
1,1-Dichloroethylene	37 ppb	3 ppb		<1 ppb		<1 ppb		<1 ppb		<1 ppb	
Solubility 500 ppm	5 ppb	0.00	0.12	0.00	0.13	0.00	0.13	0.00	0.13	0.00	0.13
Mwt 96.94		91.93%		99.35%		99.95%		100.00%		100.00%	
Benzene	1.95 ppb	<1 ppb		<1 ppb		<1 ppb		<1 ppb		<1 ppb	
Solubility 1,780 ppm	1 ppb	0.00	0.01	0.00	0.01	0.00	0.01	0.00	0.01	0.00	0.01
Mwt 78.12		75.14%		93.82%		98.46%		99.62%		99.91%	
Methylbromide	353 ppb	15 ppb		<1 ppb		<1 ppb		<1 ppb		<1 ppb	
Solubility 900 ppm	5 ppb	0.02	1.25	0.02	1.31	0.02	1.31	0.02	1.31	0.02	1.31
Mwt 95		95.88%		99.83%		99.99%		100.00%		100.00%	
Based on theoretical data only, CONSULT NEEP REPRESENTATIVE FOR WARRANTY											
Chlorobenzene	381 ppb	129 ppb		44 ppb		15 ppb		5 ppb		2 ppb	
Solubility 500 ppm	5 ppb	0.01	0.79	0.02	1.06	0.02	1.15	0.02	1.18	0.02	1.19
Mwt 112.56		66.07%		88.49%		96.09%		98.67%		99.55%	
Chloroethane	91.45 ppb	20 ppb		4 ppb		<1 ppb		<1 ppb		<1 ppb	
Solubility 5,740 ppm	5 ppb	0.00	0.39	0.00	0.48	0.00	0.50	0.00	0.50	0.00	0.50
Mwt 64.26		78.20%		95.25%		98.96%		99.77%		99.95%	
Based on theoretical data only, CONSULT NEEP REPRESENTATIVE FOR WARRANTY											
Ethyl Benzene	262.76 ppb	61 ppb		14 ppb		3 ppb		<1 ppb		<1 ppb	
Solubility 152 ppm	5 ppb	0.01	0.67	0.01	0.83	0.01	0.86	0.01	0.87	0.01	0.87
Mwt 106.16		76.87%		94.65%		98.76%		99.71%		99.93%	
Toluene	141.15 ppb	38 ppb		10 ppb		3 ppb		<1 ppb		<1 ppb	
Solubility 515 ppm	5 ppb	0.01	0.39	0.01	0.50	0.01	0.53	0.01	0.54	0.01	0.54
Mwt 92.13		72.91%		92.66%		98.01%		99.46%		99.85%	
Xylenes	103.5 ppb	25 ppb		6 ppb		2 ppb		<1 ppb		<1 ppb	
Solubility 175 ppm	5 ppb	0.00	0.26	0.00	0.32	0.01	0.34	0.01	0.34	0.01	0.34
Mwt 106		75.61%		94.05%		98.55%		99.65%		99.91%	
Vinyl Chloride	59.8 ppb	4 ppb		<1 ppb		<1 ppb		<1 ppb		<1 ppb	
Solubility 1100 ppm	2 ppb	0.00	0.32	0.00	0.34	0.00	0.34	0.00	0.34	0.00	0.34
Mwt 62.5		93.48%		99.57%		99.97%		100.00%		100.00%	
Total ppb	1576 ppb	307 ppb		82 ppb		24 ppb		7 ppb		2 ppb	
Total VOC lbs/hr - ppmv		0.06	4.50	0.07	5.29	0.08	5.49	0.08	5.54	0.08	5.56
Total		80.51%		94.81%		98.49%		99.54%		99.86%	

This report has been generated by ShallowTray Modeler software version 6.12e. This software is designed to assist a skilled operator in predicting the performance of a ShallowTray air stripping system. North East Environmental Products, Inc. (NEEP Systems) is not responsible for incidental or consequential damages resulting from the improper operation of either the software or the air stripping equipment.

Report Generated: 10/25/2005 **Modeler V6.12e 5/24/2001**

ACAD:1610PF01.dwg 10/20/05 HJB PIT



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CHECKED BY / DATE			OWNER NO. 0004	
REVISED BY / DATE			APPROVED BY	DATE
SCALE AS NOTED			DRAWING NO. FIGURE	REV. 0

FORM CADD NO. TTNUS-BH.DWG - REV 1 - 9/10/98

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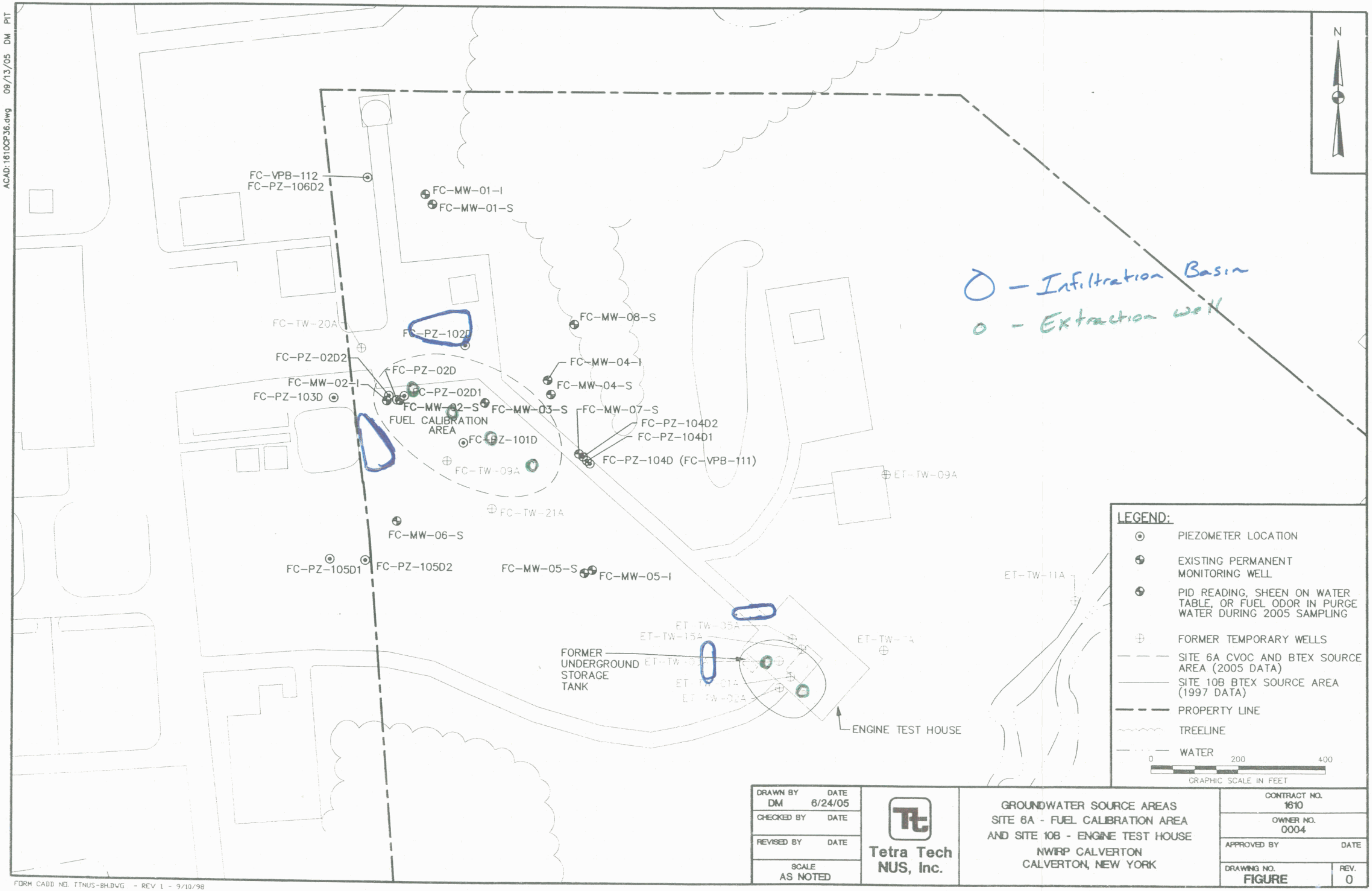

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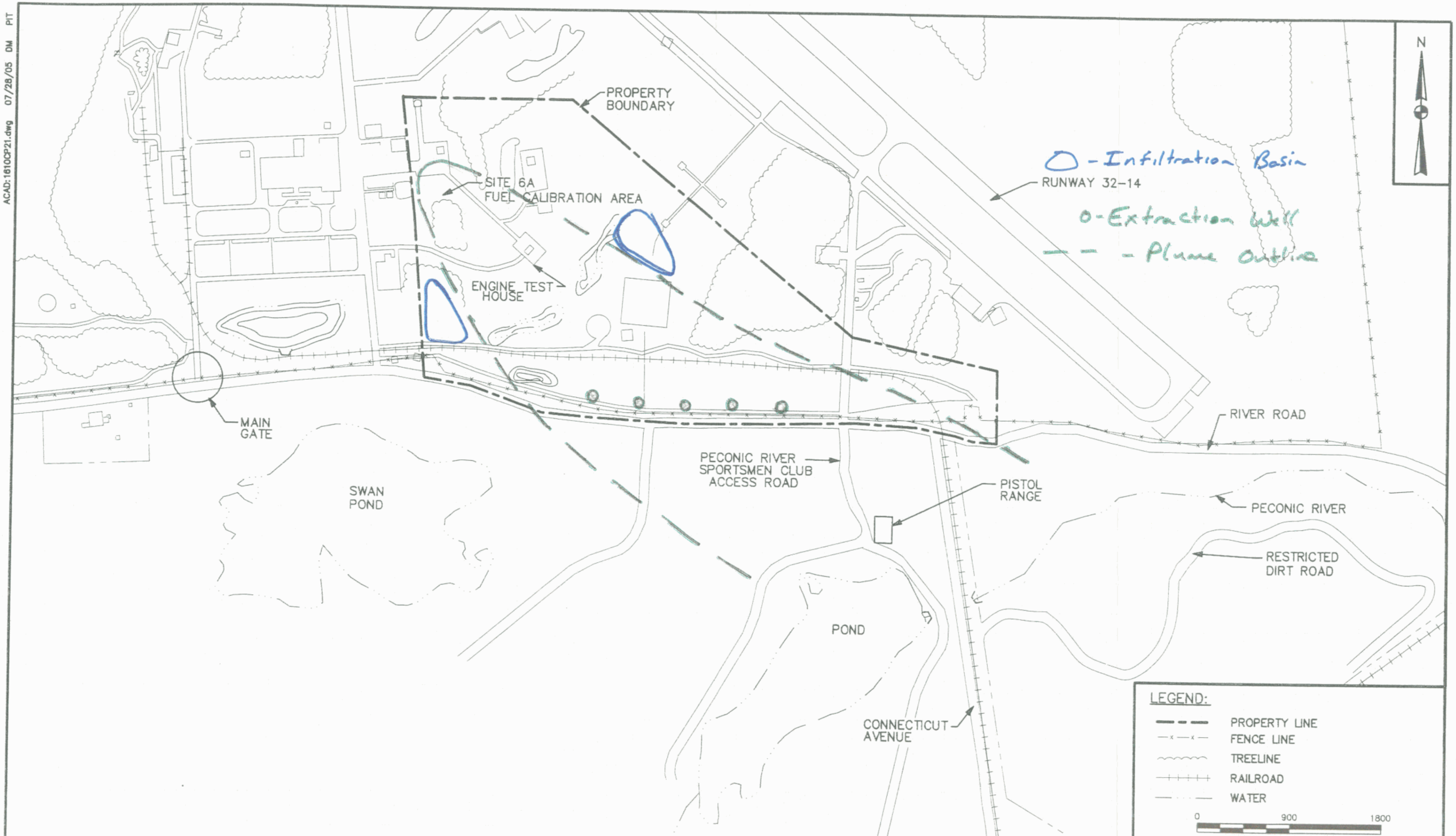

DRAWN BY DM	DATE 6/7/05	Tetra Tech NUS, Inc.	FACILITY LAYOUT SITE 6A AND SOUTHERN AREA NWIRP CALVERTON CALVERTON, NEW YORK	CONTRACT NO. 1610
CHECKED BY	DATE			OWNER NO. 0000
REVISED BY	DATE			APPROVED BY / DATE
SCALE AS NOTED				DRAWING NO. FIGURE / REV. 0

FORM CADD NO. TTNUS-BH.DWG - REV 1 - 9/10/98

C-68

C.6 - BIOSTIMULATION

HRC Design Software for Plume Area/Grid Treatment

May 2005

Regenesis Technical Support: USA (949) 366-8000 www.regenesis.com

Site Name: Site 6A Fuel Calibration Area - GW
Location: Calverton, NY
Consultant: TtNUS

Site Conceptual Model/Extent of Plume Requiring Remediation

Width of plume (intersecting gw flow direction)	270	ft			
Length of plume (parallel to gw flow direction)	370	ft		99,900	ft^2
Depth to contaminated zone	7	ft			
Thickness of contaminated saturated zone	30	ft			
Nominal aquifer soil (gravel, sand, silty sand, silt, clay, etc.)	sand				
Total porosity	0.33		Effective porosity:	0.25	
Hydraulic conductivity	100	ft/day		3.5E-02	cm/sec
Hydraulic gradient	0.0017	ft/ft			
Seepage velocity	248.2	ft/yr		0.680	ft/day
Treatment Zone Pore Volume	989,010	ft^3		7,398,784	gallons

(************Consider using several individual barriers***************)**

Dissolved Phase Electron Donor Demand	Contaminant Conc (mg/L)	Contaminant Mass (lb)	Stoichiometry cont/H_2 (wt/wt)
Tetrachloroethene (PCE)	0.00	0.0	20.7
Trichloroethene (TCE)	0.00	0.0	21.9
cis-1,2-dichloroethene (DCE)	0.00	0.0	24.2
Vinyl Chloride (VC)	0.00	0.0	31.2
1,1,1-Trichloroethane (TCA)	0.01	0.7	22.2
1,1-Dichlorochloroethane (DCA)	0.03	1.8	24.7
User added, also add stoich. demand and Koc (see pull-dowr	0.00	0.0	0.0
User added, also add stoich. demand and Koc (see pull-dowr	0.00	0.0	0.0

carbon tetrachloride <- pull-down menu

Sorbed Phase (SP) Electron Donor Demand

Soil bulk density	1.76	g/cm^3	=	110	lb/cf
Fraction of organic carbon (foc)	0.001	range: 0.0001 to 0.01			

(Values are estimated using SP = foc*Koc*Cgw) (Adjust Koc as necessary to provide realistic estimates)	Koc (L/kg)	Contaminant Conc (mg/kg)	Contaminant Mass (lb)	Stoichiometry cont/H_2 (wt/wt)
Tetrachloroethene (PCE)	371	0.00	0.0	20.7
Trichloroethene (TCE)	122	0.00	0.0	21.9
cis-1,2-dichloroethene (DCE)	80	0.00	0.0	24.2
Vinyl Chloride (VC)	2.5	0.00	0.0	31.2
1,1,1-Trichloroethane (TCA)	304	0.00	1.2	22.2
1,1-Dichlorochloroethane (DCA)	33	0.00	0.3	24.7
User added, also add stoich. demand and Koc (see pull-dowr	0	0.00	0.0	0.0
User added, also add stoich. demand and Koc (see pull-dowr	0	0.00	0.0	0.0

Competing Electron Acceptors (CEAs)	CEA Conc (mg/L)	CEA Mass (lb)	Stoich. (wt/wt) e^- acceptor/H_2
Oxygen Demand	5.00	308	8.0
Nitrate Demand	5.00	308	12.4
Bioavailable Manganese Demand	5.00	308	27.5
Bioavailable Iron Demand	25.00	1,542	55.9
Sulfate Demand	50.00	3,085	12.0

Microbial Demand Factor	3	Recommend 1-4x
Safety Factor	2	Recommend 1-4x

Injection Point Spacing and Application Rate:

Injection spacing within rows (ft)	15.0	# points per row:	18
Injection spacing between rows (ft)	60.0	# of rows:	7
Advective travel time between rows (days)	88	Total # of points:	126
		Min. required HRC application rate (lb/ft)	8.6

Project Summary			
Number of HRC delivery points (adjust as necessary for site)		126	
HRC application rate in lbs/ft (adjust as necessary for site)		8.6	
Corresponding amount of HRC per point (lb)		257	
Number of 30 lb HRC buckets per injection point		8.6	
Total number of 30 lb buckets		1081	
Total amount of HRC (lb)		32,430	
HRC unit cost ($/lb)	$	5.25	
Total Material Cost	$	**170,258**	Cost is relatively high. Please call Regenesis to confirm.
Shipping and Tax Estimates in US Dollars			
Sales tax rate: 8.00%	$	13,621	
Total material cost	$	183,878	
Shipping of HRC (call for quote)	$	6,000	
Total Regenesis Material Cost	$	**189,878**	

HRC Installation Cost Estimate (responsibility of customer to contract work)			**Other Project Costs**		
Length of each injection point (ft)		37	Design and regulatory issues	$	-
Total length for direct push for project (ft)		4,662	Groundwater monitoring and rpt	$	-
Est. daily installation rate (ft per day: 300 for push, 150 for drilling)		300	Other	$	-
Estimated points per day (10 to 30 is typical for direct push)		8.1	Other	$	-
Required number of days		16	Other	$	-
Mobilization/demobilization cost for injection subcontractor	$	2,000	Other	$	-
Daily rate for injection subcontractor	$	3,000	Other	$	-
Total injection subcontractor cost for application	$	50,000	Other	$	-
Total Install Cost (not including consultant, lab, etc.)	$	**239,878**	**Total Project Cost**	$	**239,878**

C-69

ORC Design Software for Grid Applications Using Slurry Injection

May 2005

Regenesis Technical Support: USA (949) 366-8000 www.regenesis.com

Site Name: Site 6A Fuel Calibration Area - GW
Location: Calverton, NY
Consultant: TtNUS

Estimated Plume Requiring Treatment

Width of plume (intersecting gw flow direction)	270	ft		
Length of plume (parallel to gw flow direction)	370	ft	99,900	ft^2
Depth to contaminated zone	7	ft		
Thickness of contaminated saturated zone	30	ft		
Nominal aquifer soil (gravel, sand, silty sand, silt, clay)	sand			
Total porosity	0.33	Effective porosity:	0.25	
Hydraulic conductivity	100	ft/day	3.5E-02	cm/sec
Hydraulic gradient	0.0017	ft/ft		
Seepage velocity	248.2	ft/yr	0.680	ft/day
Treatment Zone Pore Volume	989,010	ft^3	7,398,784	gallons

(***************Consider using several individual barriers***************)

Dissolved Phase Oxygen Demand:	Contaminant Conc.	Contaminant Mass	Stoichiometry (wt/wt)	ORC Dose
Individual species that represent oxygen demand:	(mg/L)	(lb)	O_2/contaminant	(lb)
Benzene	0.00	0.0	3.1	0
Toluene	0.00	0.2	3.1	7
Ethylbenzene	0.00	0.1	3.2	2
Xylenes	0.02	1.0	3.2	34
MTBE	0.00	0.0	2.7	0
cis-1,2-DCE	0.00	0.0	0.7	0
Vinyl Chloride	0.00	0.0	1.3	0
Acetone	0.01	0.4	2.2	8
2-Butanone	0.01	0.8	2.4	19
Reduced metals: Fe^{+2} and Mn^{+2}	2.00	123.4	0.10	123
TPH-g	<- pull-down menu			
Measures of total oxygen demand				
Total Petroleum Hydrocarbons (see pull-down for Koc)	0.10	6.2	3.1	191
Biological Oxygen Demand (BOD)	0.10	6.2	1.0	62
Chemical Oxygen Demand (COD)	0.10	6.2	1.0	62

Parameters for Sorbed Phase Oxygen Demand:

Soil bulk density	1.76	g/cm^3 =	110	lb/cf
Fraction of organic carbon (foc)	0.002	range: 0.0001 to 0.01		

(Estimated using sorbed phase = foc*Koc*Cgw)

(Adjust Koc as necessary to provide realistic estimates)	Koc	Contaminant Conc.	Contaminant Mass	Stoichiometry (wt/wt)	ORC Dose
Individual species that represent oxygen demand:	(L/kg)	(mg/kg)	(lb)	O_2/contaminant	(lb)
Benzene	123	0.00	0.0	3.1	0
Toluene	267	0.00	0.7	3.1	21
Ethylbenzene	327	0.00	0.2	3.2	8
Xylenes	298	0.01	3.3	3.2	107
MTBE	12	0.00	0.0	2.7	0
cis-1,2-DCE	80	0.00	0.0	0.7	0
Vinyl Chloride	2.5	0.00	0.0	1.3	0
Acetone	2.2	0.00	0.0	2.2	0
2-Butanone	31.0	0.00	0.3	2.4	6
Measures of total oxygen demand					
Total Petroleum Hydrocarbons	373	0.07	24.6	3.1	762

Summary of Estimated ORC Requirements	Dissolved Phase ORC Demand (lbs)	Sorbed Phase ORC Demand (lbs)	Additional Demand Factor (1 to 10x)	Total ORC Demand	ORC Cost	
Total BTEX, MTBE, etc.	194	142	5.0	1,678	$15,960	
Total Petroleum Hydrocarbons	191	762	2.0	1,906	$18,240	<-
Biological Oxygen Demand (BOD)	62	62	2.0	247	$2,700	
Chemical Oxygen Demand (COD)	62	62	1.5	185	$2,100	

Required ORC quantity (in 30 lb increments) --> **1,920** **pounds ORC**

Delivery Design for ORC Slurry

Spacing within rows (ft)		15.0	feet
# points per row		18	points/row
Spacing between rows (ft)	Consider tighter spacing	30.0	ft
# of rows		13	rows
Advective travel time bet. rows (days)		44	days
Number of points in grid		234	points
ORC application rate	Minimum Dose Override->	3.0	lbs/foot
Total ORC required	Minimum Dose Override->	**21,060**	lbs of ORC

Slurry Mixing Volume for Injections

Pounds per location	90	pounds
Buckets per location	3.0	buckets
Design solids content (20-40% by wt. for injections)	30%	
Volume of water required per hole (gal)	25	gallons
Total water for mixing all holes (gal)	5892	gallons
Simple ORC Backfilling: min hole dia. for 67% slurry	2.9	inches
Feasibility for slurry injection in sand: ok up to 15 lb/ft	(ok)	
Feasibility for slurry injection in silt: ok up to 10 lb/ft	(ok)	
Feasibility for slurry injection in clay: ok up to 10 lb/ft	(ok)	

Project Summary			
Number of ORC delivery points (adjust as necessary for site)		234	
ORC application rate in lbs/ft (adjust as necessary for site)		3.0	<-Minimum Dose Override
ORC bulk material for slurry injection (lbs)		21,060	
Number of 30 lb ORC buckets		702.0	
ORC bulk material cost ($/lb)	$	7.75	
Cost for bulk ORC material	$	163,215	Cost is relatively high. Please call Regenesis to confirm design.
Shipping and Tax Estimates in US Dollars			
Sales Tax (rate: 8.00%)	$	13,057	
Total Material Cost	$	176,272	
Shipping (call for amount)	$	4,000	
Total Regenesis Material Cost	**$**	**180,272**	

ORC Slurry Injection Cost Estimate (responsibility of customer to contract work)		
Footage for each point = uncontaminated interval + ORC injection interval (ft)		37
Total length for direct push for project (ft)		8,658
Estimated daily installation rate (ft per day: 300 for push, 150 for drilling)		300
Estimated points per day (10 to 30 is typical for direct push)		8.1
Required number of days		29
Mob/demob cost for injection subcontractor	$	2,000
Daily rate for injection subcontractor ($1-2K for push, $3-4K for drill rig)	$	3,000
Total injection subcontractor cost for application	$	89,000
Total Install Cost (not including consultant, lab, etc.)	**$**	**269,272**

Other Project Cost Estimates		
Design	$	-
Permitting and reporting	$	-
Construction management	$	-
Groundwater monitoring and rpts	$	-
Other	$	-
Other	$	-
Other	$	-
Other	$	-
Total Project Cost	**$**	**269,272**

C-70

HRC Design Software for Plume Area/Grid Treatment

May 2005

Regenesis Technical Support: USA (949) 366-8000 www.regenesis.com

Site Name: Site 10B - Engine Test House - GW
Location: Calverton, NY
Consultant: TtNUS

Site Conceptual Model/Extent of Plume Requiring Remediation

Width of plume (intersecting gw flow direction)	150	ft			
Length of plume (parallel to gw flow direction)	170	ft		25,500	ft^2
Depth to contaminated zone	10	ft			
Thickness of contaminated saturated zone	20	ft			
Nominal aquifer soil (gravel, sand, silty sand, silt, clay, etc.)	sand				
Total porosity	0.33		Effective porosity:	0.25	
Hydraulic conductivity	100	ft/day		3.5E-02	cm/sec
Hydraulic gradient	0.0017	ft/ft			
Seepage velocity	248.2	ft/yr		0.680	ft/day
Treatment Zone Pore Volume	168,300	ft^3		1,259,052	gallons

Dissolved Phase Electron Donor Demand	Contaminant Conc (mg/L)	Contaminant Mass (lb)	Stoichiometry cont/H_2 (wt/wt)
Tetrachloroethene (PCE)	0.00	0.0	20.7
Trichloroethene (TCE)	0.00	0.0	21.9
cis-1,2-dichloroethene (DCE)	0.00	0.0	24.2
Vinyl Chloride (VC)	0.00	0.0	31.2
1,1,1-Trichloroethane (TCA)	0.17	1.7	22.2
1,1-Dichlorochloroethane (DCA)	0.05	0.5	24.7
Trichlorotrifluoroethane	0.15	1.6	15.6
User added, also add stoich. demand and Koc (see pull-dowr	0.00	0.0	0.0

carbon tetrachloride <- pull-down menu

Sorbed Phase (SP) Electron Donor Demand

Soil bulk density	1.76	g/cm^3 =	110	lb/cf
Fraction of organic carbon (foc)	0.001	range: 0.0001 to 0.01		

(Values are estimated using SP = foc*Koc*Cgw) (Adjust Koc as necessary to provide realistic estimates)	Koc (L/kg)	Contaminant Conc (mg/kg)	Contaminant Mass (lb)	Stoichiometry cont/H_2 (wt/wt)
Tetrachloroethene (PCE)	371	0.00	0.0	20.7
Trichloroethene (TCE)	122	0.00	0.0	21.9
cis-1,2-dichloroethene (DCE)	80	0.00	0.0	24.2
Vinyl Chloride (VC)	2.5	0.00	0.0	31.2
1,1,1-Trichloroethane (TCA)	304	0.05	2.8	22.2
1,1-Dichlorochloroethane (DCA)	33	0.00	0.1	24.7
Trichlorotrifluoroethane	389	0.06	3.3	15.6
User added, also add stoich. demand and Koc (see pull-dowr	0	0.00	0.0	0.0

Competing Electron Acceptors (CEAs)	CEA Conc (mg/L)	CEA Mass (lb)	Stoich. (wt/wt) e^- acceptor/H_2
Oxygen Demand	5.00	52	8.0
Nitrate Demand	5.00	52	12.4
Bioavailable Manganese Demand	5.00	52	27.5
Bioavailable Iron Demand	25.00	262	55.9
Sulfate Demand	50.00	525	12.0

Microbial Demand Factor	3	Recommend 1-4x
Safety Factor	2	Recommend 1-4x

Injection Point Spacing and Application Rate:

Injection spacing within rows (ft)	15.0	# points per row:	10
Injection spacing between rows (ft)	60.0	# of rows:	3
Advective travel time between rows (days)	88	Total # of points:	30
		Min. required HRC application rate (lb/ft)	9.5

Project Summary			
Number of HRC delivery points (adjust as necessary for site)			30
HRC application rate in lbs/ft (adjust as necessary for site)			9.5
Corresponding amount of HRC per point (lb)			190
Number of 30 lb HRC buckets per injection point			6.3
Total number of 30 lb buckets			190
Total amount of HRC (lb)			5,700
HRC unit cost ($/lb)		$	6.00
Total Material Cost		$	**34,200**
Shipping and Tax Estimates in US Dollars			
Sales tax	rate: 8.00%	$	2,736
Total material cost		$	36,936
Shipping of HRC (call for quote)		$	1,000
Total Regenesis Material Cost		$	**37,936**

HRC Installation Cost Estimate (responsibility of customer to contract work)			Other Project Costs		
Length of each injection point (ft)		30	Design and regulatory issues	$	-
Total length for direct push for project (ft)		900	Groundwater monitoring and rpt	$	-
Est. daily installation rate (ft per day: 300 for push, 150 for drilling)		300	Other	$	-
Estimated points per day (10 to 30 is typical for direct push)		10.0	Other	$	-
Required number of days		3	Other	$	-
Mobilization/demobilization cost for injection subcontractor	$	2,000	Other	$	-
Daily rate for injection subcontractor	$	3,000	Other	$	-
Total injection subcontractor cost for application	$	11,000	Other	$	-
Total Install Cost (not including consultant, lab, etc.)	$	**48,936**	**Total Project Cost**	**$**	**48,936**

ORC Design Software for Grid Applications Using Slurry Injection

May 2005

ORC OXYGEN RELEASE COMPOUND

Regenesis Technical Support: USA (949) 366-8000 www.regenesis.com

Site Name: Site 10B - Engine Test House - GW
Location: Calverton, NY
Consultant: TtNUS

Estimated Plume Requiring Treatment

Width of plume (intersecting gw flow direction)	150	ft		
Length of plume (parallel to gw flow direction)	170	ft	25,500	ft^2
Depth to contaminated zone	10	ft		
Thickness of contaminated saturated zone	20	ft		
Nominal aquifer soil (gravel, sand, silty sand, silt, clay)	sand			
Total porosity	0.33	Effective porosity:	0.25	
Hydraulic conductivity	100	ft/day	3.5E-02	cm/sec
Hydraulic gradient	0.0017	ft/ft		
Seepage velocity	248.2	ft/yr	0.680	ft/day
Treatment Zone Pore Volume	168,300	ft^3	1,259,052	gallons

Dissolved Phase Oxygen Demand:

Individual species that represent oxygen demand:	Contaminant Conc. (mg/L)	Contaminant Mass (lb)	Stoichiometry (wt/wt) O_2/contaminant	ORC Dose (lb)
Benzene	0.00	0.0	3.1	0
Toluene	0.02	0.2	3.1	7
Ethylbenzene	0.07	0.7	3.2	23
Xylenes	0.01	0.1	3.2	4
MTBE	0.00	0.0	2.7	0
cis-1,2-DCE	0.00	0.0	0.7	0
Vinyl Chloride	0.00	0.0	1.3	0
User added, add stoich. demand and Koc (see pull-down)	0.00	0.0	0.0	0
User added, add stoich. demand and Koc (see pull-down)	0.00	0.0	0.0	0
Reduced metals: Fe^{+2} and Mn^{+2}	2.00	21.0	0.10	21
TPH-g	<- pull-down menu			
Measures of total oxygen demand				
Total Petroleum Hydrocarbons (see pull-down for Koc)	0.10	1.0	3.1	33
Biological Oxygen Demand (BOD)	0.00	0.0	1.0	0
Chemical Oxygen Demand (COD)	0.00	0.0	1.0	0

Parameters for Sorbed Phase Oxygen Demand:

Soil bulk density	1.76	g/cm^3 =	110	lb/cf
Fraction of organic carbon (foc)	0.001	range: 0.0001 to 0.01		

(Estimated using sorbed phase = foc*Koc*Cgw)
(Adjust Koc as necessary to provide realistic estimates)

Individual species that represent oxygen demand:	Koc (L/kg)	Contaminant Conc. (mg/kg)	Contaminant Mass (lb)	Stoichiometry (wt/wt) O_2/contaminant	ORC Dose (lb)
Benzene	123	0.00	0.0	3.1	0
Toluene	267	0.01	0.3	3.1	10
Ethylbenzene	327	0.02	1.2	3.2	40
Xylenes	298	0.00	0.2	3.2	6
MTBE	12	0.00	0.0	2.7	0
cis-1,2-DCE	80	0.00	0.0	0.7	0
Vinyl Chloride	2.5	0.00	0.0	1.3	0
User added, add stoich. demand and Koc (see pull-down)	0.0	0.00	0.0	0.0	0
User added, add stoich. demand and Koc (see pull-down)	0.0	0.00	0.0	0.0	0
Measures of total oxygen demand					
Total Petroleum Hydrocarbons	373	0.04	2.1	3.1	65

Summary of Estimated ORC Requirements

	Dissolved Phase ORC Demand (lbs)	Sorbed Phase ORC Demand (lbs)	Additional Demand Factor (1 to 10x)	Total ORC Demand	ORC Cost	
Total BTEX, MTBE, etc.	55	56	5.0	554	$5,700	<-
Total Petroleum Hydrocarbons	33	65	2.0	195	$2,100	
Biological Oxygen Demand (BOD)	0	0	2.0	0	$0	
Chemical Oxygen Demand (COD)	0	0	1.5	0	$0	

Required ORC quantity (in 30 lb increments) --> 570 **pounds ORC**

Delivery Design for ORC Slurry

Spacing within rows (ft)		15.0	feet
# points per row		10	points/row
Spacing between rows (ft)		15.0	ft
# of rows		12	rows
Advective travel time bet. rows (days)		22	days
Number of points in grid		120	points
ORC application rate	Minimum Dose Override->	3.0	lbs/foot
Total ORC required	Minimum Dose Override->	7,200	lbs of ORC

Slurry Mixing Volume for Injections

Pounds per location	60	pounds
Buckets per location	2.0	buckets
Design solids content (20-40% by wt. for injections)	30%	
Volume of water required per hole (gal)	17	gallons
Total water for mixing all holes (gal)	2014	gallons
Simple ORC Backfilling: min hole dia. for 67% slurry	2.9	inches
Feasibility for slurry injection in sand: ok up to 15 lb/ft	(ok)	
Feasibility for slurry injection in silt: ok up to 10 lb/ft	(ok)	
Feasibility for slurry injection in clay: ok up to 10 lb/ft	(ok)	

Project Summary			
Number of ORC delivery points (adjust as necessary for site)		120	
ORC application rate in lbs/ft (adjust as necessary for site)		3.0	<-Minimum Dose Override
ORC bulk material for slurry injection (lbs)		7,200	
Number of 30 lb ORC buckets		240.0	
ORC bulk material cost ($/lb)	$	8.50	
Cost for bulk ORC material	$	61,200	Cost is relatively high. Please call Regenesis to confirm design.
Shipping and Tax Estimates in US Dollars			
Sales Tax rate: 8.00%	$	4,896	
Total Material Cost	$	66,096	
Shipping (call for amount)	$	800	
Total Regenesis Material Cost	**$**	**66,896**	

ORC Slurry Injection Cost Estimate (responsibility of customer to contract work)		
Footage for each point = uncontaminated interval + ORC injection interval (ft)		30
Total length for direct push for project (ft)		3,600
Estimated daily installation rate (ft per day: 300 for push, 150 for drilling)		300
Estimated points per day (10 to 30 is typical for direct push)		10.0
Required number of days		12
Mob/demob cost for injection subcontractor	$	2,000
Daily rate for injection subcontractor ($1-2K for push, $3-4K for drill rig)	$	3,000
Total injection subcontractor cost for application	$	38,000
Total Install Cost (not including consultant, lab, etc.)	**$**	**104,896**

Other Project Cost Estimates		
Design	$	-
Permitting and reporting	$	-
Construction management	$	-
Groundwater monitoring and rpts	$	-
Other	$	-
Other	$	-
Other	$	-
Other	$	-
Total Project Cost	**$**	**104,896**

C-72

HRC Design Software for Barrier Treatment	May 2005
Regenesis Technical Support: USA (949) 366-8000 www.regenesis.com	
Site Name: Onsite Southern Area Plume	
Location: Calverton, NY	
Consultant: TtNUS	

Site Conceptual Model/Extent of Plume Requiring Remediation

Length of Barrier (intersecting gw flow direction)	2000	ft		
Depth to contaminated zone	10	ft		
Thickness of contaminated saturated zone	30	ft		
Aquifer soil type (gravel, sand, silty sand, silt, clay, etc.)	sand			
Effective porosity	0.25			
Hydraulic conductivity	100	ft/day	3.5E-02	cm/sec
Hydraulic gradient	0.0017	ft/ft		
Seepage velocity	248.2	ft/yr	0.680	ft/day

Dissolved Phase Electron Donor Demand

	Contaminant Conc (mg/L)	Contaminant Mass (lb/yr)	Stoichiometry cont/H_2 (wt/wt)
Tetrachloroethene (PCE)	0.00	0.00	20.7
Trichloroethene (TCE)	0.00	0.00	21.9
cis-1,2-dichloroethene (DCE)	0.00	0.00	24.2
Vinyl Chloride (VC)	0.00	0.87	31.2
1,1,1-Trichloroethane (TCA)	0.01	2.40	22.2
1,1-Dichlorochloroethane (DCA)	0.00	0.72	24.7
trichlorotrifluoroethane	0.01	2.20	15.6
methylene chloride	0.00	0.10	21.2

trichlorotrifluoroethane <- **pull-down menu**

Competing Electron Acceptors:

	CEA Conc (mg/L)	CEA Mass (lb/yr)	Stoich. (wt/wt) e^- acceptor/H_2
Oxygen Demand	5.00	1,161.18	8.0
Nitrate Demand	5.00	1,161.18	12.4
Bioavailable Manganese Demand	5.00	1,161.18	27.5
Bioavailable Iron Demand	25.00	5,805.91	55.9
Sulfate Demand	50.00	11,611.82	12.0

Microbial Demand Factor	3	Recommend 1-4x
Safety Factor	2	Recommend 1-4x
Lifespan for one application	1	Year(s)

Injection Spacing and Dose:

Number of rows in barrier	2	rows
Spacing within rows	9	ft on center
Effective spacing perpendicular to flow (ft)	4.5	
Total number of HRC injection locations	445	points
Minimum required HRC application rate (lb/ft)	9.1	

Project Summary			
Number of HRC delivery points (adjust as necessary for site)		445	Call Regenesis for suggestions to minimize no. of points
HRC application rate in lbs/ft (adjust as necessary for site)		9.1	
Corresponding amount of HRC per point (lb)		274	
Number of 30 lb HRC buckets per injection point		9.1	
Total number of 30 lb buckets		4062	
Total amount of HRC (lb)		121,860	
HRC unit cost ($/lb)	$	5.00	
Total Material Cost	**$**	**609,300**	Cost is relatively high. Please call Regenesis to confirm.
Shipping and Tax Estimates in US Dollars			
Sales Tax rate: 8.00%	$	48,744	
Total Material Cost	$	658,044	
Shipping of HRC (call for quote)	$	12,000	
Total Regenesis Material Cost	**$**	**670,044**	

HRC Installation Cost Estimate (responsibility of customer to contract work)			**Other Project Costs**		
Length of each injection point (ft)		40	Design and Regulatory Issues	$	-
Total length for direct push for project (ft)		17,800	Groundwater monitoring and reporting	$	-
Estimated daily installation rate (ft per day: 300 for push, 150 for drilling)		300	Other	$	-
Estimated points per day (10 to 30 is typical for direct push)		7.5	Other	$	-
Required number of days		60	Other	$	-
Mobilization/demobilization cost for injection subcontractor	$	2,000	Other	$	-
Daily rate for injection subcontractor	$	3,000	Other	$	-
Total injection subcontractor cost for application	$	182,000	Other	$	-
Total Install Cost (not including consultant, lab, etc.)	**$**	**852,044**	**Total Project Cost**	**$**	**852,044**

APPENDIX D

COST ESTIMATES

D.1 - ALTERNATIVE S2
D.2 - ALTERNATIVE S3
D.3 - ALTERNATIVE S4
D.4 - ALTERNATIVE S5
D.5 - ALTERNATIVE S6
D.6 - ALTERNATIVE S7
D.7 - ALTERNATIVE SAGW2
D.8 - ALTERNATIVE SAGW3
D.9 - ALTERNATIVE SAGW4
D.10 - ALTERNATIVE SAGW5
D.11 - ALTERNATIVE OSAGP2
D.12 - ALTERNATIVE OSAGP3
D.13 - ALTERNATIVE OSAGP4

D.1 - ALTERNATIVE S2

LAND USE CONTROLS/DEED NOTIFICATIONS AND MONITORING

SITE 6A - FUEL CALIBRATION AREA, SITE 10B - ENGINE TEST HOUSE, AND ONSITE SOUTHERN AREA
NWIRP CALVERTON
CALVERTON, NEW YORK
ALT S2: LAND USE CONTROLS / DEED NOTIFICATIONS AND MONITORING
CAPITAL COST

Item	Quantity	Unit	Unit Cost				Extended Cost				Subtotal
			Subcontract	Material	Labor	Equipment	Subcontract	Material	Labor	Equipment	
1 PROJECT PLANNING											
1.1 Prepare Remedial Action Plan	50	hr			$52.50		$0	$0	$2,625	$0	$2,625
1.2 Land Use Controls / Deeds Notifications	150	hr			$52.50		$0	$0	$7,875	$0	$7,875
2 SOIL MONITORING											
2.1 Mobilize / Demobilize DPT Rig	1	ls	$3,000.00				$3,000	$0	$0	$0	$3,000
2.2 DPT Drill (2 Samples per Boring), 15 Borings Each Site, 10 ft Deep	300	ft	$20.00				$6,000	$0	$0	$0	$6,000
2.3 Analyze VOCs, SVOCs, PAHs, Pest/PCBs, DRO, TCLP Metals	60	ea	$1,260.00	$5.00	$50.00		$75,600	$300	$3,000	$0	$78,900
Subtotal							$84,600	$300	$13,500	$0	$98,400
Local Area Adjustments							100.0%	112.3%	130.4%	130.4%	
							$84,600	$337	$17,604	$0	$102,541
Overhead on Labor Cost @ 30%									$5,281		$5,281
G & A on Labor Cost @ 10%									$1,760		$1,760
G & A on Material Cost @ 10%								$34			$34
G & A on Subcontract Cost @ 10%							$8,460				$8,460
G & A on Equipment Cost @ 10%										$0	$0
Total Direct Cost							$93,060	$371	$24,646	$0	$118,076
Indirects on Total Direct Cost @ 35%											$41,327
Profit on Total Direct Cost @ 10%											$11,808
Subtotal											$171,210
Health & Safety Monitoring @ 2%											$3,424
Total Field Cost											$174,635
Contingency on Total Field Costs @ 15%											$26,195
Engineering on Total Field Cost @ 15%											$26,195
TOTAL COST											**$227,025**

SITE 6A - FUEL CALIBRATION AREA, SITE 10B - ENGINE TEST HOUSE, AND ONSITE SOUTHERN AREA
NWIRP CALVERTON
CALVERTON, NEW YORK
ALT S2: LAND USE CONTROLS / DEED NOTIFICATIONS AND MONITORING
ANNUAL COST

Item	Item Cost Annually	Item Cost Every 5 Years	Notes
Soil Sampling		$6,050	DPT Rig and Labor for 8 Soil Samples (4 per Site) Every 5 Years
Soil Analytical		$6,960	8 Soil Samples (4 per Site) Every 5 Years, Analyzed for VOCs, SVOCs, PAHs, & DRO
Inspection	$1,000		Annual LUC inspection (assume 8 hours at $50/hr plus expenses)
5-Year Site Review		$23,000	
TOTALS	$1,000	$36,010	

SITE 6A - FUEL CALIBRATION AREA, SITE 10B - ENGINE TEST HOUSE, AND ONSITE SOUTHERN AREA
NWIRP CALVERTON
CALVERTON, NEW YORK
ALT S2: LAND USE CONTROLS / DEED NOTIFICATIONS AND MONITORING
PRESENT WORTH ANALYSIS

Year	Capital Cost	Annual Cost	Total Year Cost	Annual Discount Rate at 7%	Present Worth
0	$227,025		$227,025	1.000	$227,025
1		$1,000	$1,000	0.935	$935
2		$1,000	$1,000	0.873	$873
3		$1,000	$1,000	0.816	$816
4		$1,000	$1,000	0.763	$763
5		$37,010	$37,010	0.713	$26,388
6		$1,000	$1,000	0.666	$666
7		$1,000	$1,000	0.623	$623
8		$1,000	$1,000	0.582	$582
9		$1,000	$1,000	0.544	$544
10		$37,010	$37,010	0.508	$18,801
11		$1,000	$1,000	0.475	$475
12		$1,000	$1,000	0.444	$444
13		$1,000	$1,000	0.415	$415
14		$1,000	$1,000	0.388	$388
15		$37,010	$37,010	0.362	$13,398
16		$1,000	$1,000	0.339	$339
17		$1,000	$1,000	0.317	$317
18		$1,000	$1,000	0.296	$296
19		$1,000	$1,000	0.277	$277
20		$37,010	$37,010	0.258	$9,549
21		$1,000	$1,000	0.242	$242
22		$1,000	$1,000	0.226	$226
23		$1,000	$1,000	0.211	$211
24		$1,000	$1,000	0.197	$197
25		$37,010	$37,010	0.184	$6,810
26		$1,000	$1,000	0.172	$172
27		$1,000	$1,000	0.161	$161
28		$1,000	$1,000	0.150	$150
29		$1,000	$1,000	0.141	$141
30		$37,010	$37,010	0.131	$4,848
				TOTAL PRESENT WORTH	$317,072

D.2 - ALTERNATIVE S3
EXCAVATION AND OFF-SITE TREATMENT AND DISPOSAL

SITE 6A - FUEL CALIBRATION AREA, SITE 10B - ENGINE TEST HOUSE, AND ONSITE SOUTHERN AREA
NWIRP CALVERTON
CALVERTON, NEW YORK
ALT S3: EXCAVATION & OFF-SITE TREATMENT AND DISPOSAL
CAPITAL COST

Item	Quantity	Unit	Unit Cost				Extended Cost				Subtotal
			Subcontract	Material	Labor	Equipment	Subcontract	Material	Labor	Equipment	
1 PROJECT PLANNING											
1.1 Prepare Remedial Action Plan	300	hr			$52.50		$0	$0	$15,750	$0	$15,750
2 MOBILIZATION/DEMOBILIZATION AND FIELD SUPPORT											
2.1 Office Trailer	6	mo		$202.50			$0	$1,215	$0	$0	$1,215
2.2 Storage Trailer	6	mo		$105.00			$0	$630	$0	$0	$630
2.3 Survey, Pre- and Post-Remediation	16.0	ac	$1,200.00				$19,200	$0	$0	$0	$19,200
2.4 Equipment Mobilization/Demob, Less than 150 HP	6	ea			$55.00	$112.00	$0	$0	$330	$672	$1,002
2.5 Equipment Mobilization/Demob, Greater than 150 HP	2	ea			$73.00	$175.00	$0	$0	$146	$350	$496
2.6 Site Utilities	6	mo		$427.00			$0	$2,562	$0	$0	$2,562
2.7 Truck Scale	6	mo				$3,100.00	$0	$0	$0	$18,600	$18,600
3 DECONTAMINATION											
3.1 Equipment Decon Pad	1	ls		$5,800.00	$6,650.00	$700.00	$0	$5,800	$6,650	$700	$13,150
3.2 Decontamination Services	2	mo		$210.00	$1,800.00	$315.00	$0	$420	$3,600	$630	$4,650
3.3 Decon Water	2,000	gal		$0.20			$0	$400	$0	$0	$400
3.4 Decon Water Storage Tank, 4,000 gallon	4	mo				$580.00	$0	$0	$0	$2,320	$2,320
3.5 Clean Water Storage Tank, 4,000 gallon	4	mo				$580.00	$0	$0	$0	$2,320	$2,320
3.6 Disposal of Decon Waste (Liquid & Solid)	4	mo	$900.00				$3,600	$0	$0	$0	$3,600
4 PRE-DESIGN INVESTIGATION											
4.1 Mobilize / Demobilize DPT Rig	1	ls	$3,000.00				$3,000	$0	$0	$0	$3,000
4.2 DPT Drill (2 Samples per Boring), 15 Borings Per Site, 10 ft Deep	300	ft	$20.00				$6,000	$0	$0	$0	$6,000
4.3 Analyze VOCs, SVOCs, PAHs, Pest/PCBs, DRO, and TCLP Metals	16	ea	$1,260.00	$5.00	$50.00		$20,160	$80	$800	$0	$21,040
5 DEMOLITION AND EXCAVATION											
5.1 Demolition, Site 6A Concrete Pad, 1 ft Thick, Reinforced	320	cy			$50.00	$34.50	$0	$0	$16,000	$11,040	$27,040
5.2 Demolition, Site 10B Concrete Pad, 1 ft Thick, Reinforced	240	cy			$50.00	$34.50	$0	$0	$12,000	$8,280	$20,280
5.3 Shut Off Utilities, Site 10B Building	1	ls	$250.00				$250	$0	$0	$0	$250
5.4 Demolition, Site 10B, Building	3,750	sf	$7.00				$26,250	$0	$0	$0	$26,250
5.5 Building Steel Recycling	25	cy	$0.00				$0	$0	$0	$0	$0
5.6 Concrete Disposal, Pad and Building	575	cy	$29.55				$16,991	$0	$0	$0	$16,991
5.7 Excavator, 1 CY	3	mo			$6,031.20	$9,677.80	$0	$0	$18,094	$29,033	$47,127
5.8 Front End Loader, 3 CY	3	mo			$5,821.20	$6,737.00	$0	$0	$17,464	$20,211	$37,675
5.9 Lined Gravel Pad to Drain Free Product from Soil	1,000	sf	$3.42	$3.98	$2.23	$0.59	$3,420	$3,980	$2,230	$590	$10,220
5.10 Pump, 2 inch, Centrifugal	3	mo				$921.00	$0	$0	$0	$2,763	$2,763
5.11 Polyethylene Tank	3	mo	$735.00				$2,205	$0	$0	$0	$2,205
5.12 Disposal of Free Product	860	gal	$2.85				$2,451	$0	$0	$0	$2,451
5.13 Disposal of Water Drained from Excavated Soil	860	gal	$0.20				$172	$0	$0	$0	$172
5.14 Confirmation Test (VOCs, SVOCs, PAHs, Pest/PCBs, & DRO)	16	ea	$1,550.00	$5.00	$50.00	$10.00	$24,800	$80	$800	$160	$25,840
6 DISPOSAL											
6.1 Waste Characterization Testing (TCLP)	6	ea	$785.00	$5.00	$30.00		$4,710	$30	$180	$0	$4,920
6.2 Hazardous Soil Transportation and Disposal, Site 6A	1,140	tons	$245.50				$279,870	$0	$0	$0	$279,870
6.3 Non-Hazardous Soil Transportation and Disposal Site 6A	7,760	tons	$97.03				$752,953	$0	$0	$0	$752,953
6.4 Soil with Petroleum, Trans and Treatment/Disposal, Site 10B	2,030	tons	$75.00				$152,250	$0	$0	$0	$152,250
7 SITE RESTORATION											
7.1 Topsoil, 6 inches Thick	280	cy		$26.30	$0.21	$0.60	$0	$7,364	$59	$168	$7,591
7.2 Subsoil, Replace 2 Ft Thick Smear Zone	7,750	cy		$21.74	$0.28	$0.70	$0	$168,485	$2,170	$5,425	$176,080
7.3 Fine Grading and Seeding, Incl. Lime, Fert, and Seed	5,774	sy		$0.35	$1.35	$0.22	$0	$2,021	$7,795	$1,270	$11,086
8 MISCELLANEOUS											
8.1 Construction Oversite (3p * 3 months)	189	mn-days			$240.00		$0	$0	$45,360	$0	$45,360
8.2 Post Construction Documents	400	hr			$52.50		$0	$0	$21,000	$0	$21,000
Subtotal							$1,318,282	$193,067	$170,427	$104,533	$1,786,309
Local Area Adjustments							100.0%	112.3%	130.4%	130.4%	
							$1,318,282	$216,814	$222,237	$136,311	$1,893,643
Overhead on Labor Cost @ 30%									$66,671		$66,671

SITE 6A - FUEL CALIBRATION AREA, SITE 10B - ENGINE TEST HOUSE, AND ONSITE SOUTHERN AREA
NWIRP CALVERTON
CALVERTON, NEW YORK
ALT S3: EXCAVATION & OFF-SITE TREATMENT AND DISPOSAL
CAPITAL COST

Item	Quantity	Unit	Unit Cost				Extended Cost				Subtotal
			Subcontract	Material	Labor	Equipment	Subcontract	Material	Labor	Equipment	
G & A on Labor Cost @	10%								$22,224		$22,224
G & A on Material Cost @	10%							$21,681			$21,681
G & A on Subcontract Cost @	10%						$131,828				$131,828
G & A on Equipment Cost @	10%									$13,631	$13,631
Total Direct Cost							$1,450,110	$238,496	$311,131	$149,942	$2,149,679
Indirects on Total Direct Cost @	35%		(Total Direct Cost minus Transportation and Disposal Costs)								$329,487
Profit on Total Direct Cost @	10%										$214,968
Subtotal											$2,694,134
Health & Safety Monitoring @	2%										$53,883
Total Field Cost											$2,748,017
Contingency on Total Field Costs @	25%										$687,004
Engineering on Total Field Cost @	10%										$274,802
TOTAL COST											**$3,709,822**

D.3 - ALTERNATIVE S4

EXCAVATION, ON-SITE TREATMENT (THERMAL), AND ON-SITE RE-USE

SITE 6A - FUEL CALIBRATION AREA, SITE 10B - ENGINE TEST HOUSE, AND ONSITE SOUTHERN AREA
NWIRP CALVERTON
CALVERTON, NEW YORK
ALT S4: EXCAVATION, ON-SITE TREATMENT (THERMAL), AND ON-SITE RE-USE OF SITES 6A AND 10B SOIL
CAPITAL COST

Item	Quantity	Unit	Unit Cost				Extended Cost				Subtotal
			Subcontract	Material	Labor	Equipment	Subcontract	Material	Labor	Equipment	
1 PROJECT PLANNING											
1.1 Prepare Remedial Action Plan	1,000	hr			$52.50		$0	$0	$52,500	$0	$52,500
2 MOBILIZATION/DEMOBILIZATION AND FIELD SUPPORT											
2.1 Office Trailer	6.0	mo		$202.50			$0	$1,215	$0	$0	$1,215
2.2 Storage Trailer	6.0	mo		$105.00			$0	$630	$0	$0	$630
2.3 Survey, Pre- and Post-Remediation	8.0	ac	$1,200.00				$9,600	$0	$0	$0	$9,600
2.4 Equipment Mobilization/Demob, Less than 150 HP	2	ea			$55.00	$112.00	$0	$0	$110	$224	$334
2.5 Equipment Mobilization/Demob, Greater than 150 HP	2	ea			$73.00	$175.00	$0	$0	$146	$350	$496
2.6 Site Utilities	6	mo		$427.00			$0	$2,562	$0	$0	$2,562
2.7 Materials Handling Pad	1,000	sf		$1.68	$0.72	$0.47	$0	$1,680	$720	$470	$2,870
3 DECONTAMINATION											
3.1 Equipment Decon Pad	1	ls		$5,800.00	$6,650.00	$700.00	$0	$5,800	$6,650	$700	$13,150
3.2 Decontamination Services	2.5	mo		$210.00	$1,800.00	$315.00	$0	$525	$4,500	$788	$5,813
3.3 Decon Water	2,500	gal		$0.20			$0	$500	$0	$0	$500
3.4 Decon Water Storage Tank, 4,000 gallon	2.5	mo				$580.00	$0	$0	$0	$1,450	$1,450
3.5 Clean Water Storage Tank, 4,000 gallon	2.5	mo				$580.00	$0	$0	$0	$1,450	$1,450
3.6 Disposal of Decon Waste (Liquid & Solid)	2.5	mo	$900.00				$2,250	$0	$0	$0	$2,250
4 PRE-DESIGN INVESTIGATION											
4.1 Mobilize / Demobilize DPT Rig	1	ls	$3,000.00				$3,000	$0	$0	$0	$3,000
4.2 DPT Drill (2 Samples per Boring), 15 Borings Per Site, 10 ft Deep	300	ft	$20.00				$6,000	$0	$0	$0	$6,000
4.3 Analyze VOCs, SVOCs, PAHs, Pest/PCBs, DRO, and TCLP Metals	60	ea	$1,260.00	$5.00	$50.00		$75,600	$300	$3,000	$0	$78,900
5 DEMOLITION AND EXCAVATION											
5.1 Demolition, Site 6A Concrete Pad, 1 ft Thick, Reinforced	320	cy			$50.00	$34.50	$0	$0	$16,000	$11,040	$27,040
5.2 Demolition, Site 10B Concrete Pad, 1 ft Thick, Reinforced	240	cy			$50.00	$34.50	$0	$0	$12,000	$8,280	$20,280
5.3 Shut Off Utilities, Site 10B Building	1	ls	$250.00				$250	$0	$0	$0	$250
5.4 Demolition, Site 10B, Building	3,750	sf	$7.00				$26,250	$0	$0	$0	$26,250
5.5 Building Steel Recycling	25	cy	$0.00				$0	$0	$0	$0	$0
5.6 Concrete Disposal, Pad and Building	575	cy	$29.55				$16,991	$0	$0	$0	$16,991
5.7 Excavator, 1 CY	6.0	mo			$6,031.20	$9,677.80	$0	$0	$36,187	$58,067	$94,254
5.8 Front End Loader, 3 CY	6.0	mo			$5,821.20	$6,737.00	$0	$0	$34,927	$40,422	$75,349
5.9 Lined Gravel Pad to Drain Free Product from Soil	1,000	sf	$3.42	$3.98	$2.23	$0.59	$3,420	$3,980	$2,230	$590	$10,220
5.10 Pump, 2 inch, Centrifugal	6.0	mo				$921.00	$0	$0	$0	$5,526	$5,526
5.11 Polyethylene Tank	6.0	mo	$735.00				$4,410	$0	$0	$0	$4,410
5.12 Disposal of Free Product	860	gal	$2.85				$2,451	$0	$0	$0	$2,451
5.13 Disposal of Water Drained from Excavated Soil	860	gal	$0.20				$172	$0	$0	$0	$172
5.14 Confirmation Test (VOCs, SVOCs, PAHs, Pest/PCBs, & DRO)	16	ea	$1,550.00	$5.00	$50.00	$10.00	$24,800	$80	$800	$160	$25,840
6 ON-SITE TREATMENT AND REUSE											
6.1 Mobilization / Demobilization / Set-up / Filter Cake Disposal	1	ls	$485,000.00				$485,000	$0	$0	$0	$485,000
6.2 Soil Treatment	10,900	tons	$105.00				$1,144,500	$0	$0	$0	$1,144,500
7 SITE RESTORATION											
7.1 Topsoil, 6 inches Thick	280	cy		$26.30	$0.21	$0.60	$0	$7,364	$59	$168	$7,591
7.2 Fine Grading and Seeding, Incl. Lime, Fert, and Seed	5,774	sy		$0.35	$1.35	$0.22	$0	$2,021	$7,796	$1,270	$11,087
8 MISCELLANEOUS											
8.1 Construction Oversite (3p * 3.5 months)	221	mn-days			$240.00		$0	$0	$52,920	$0	$52,920
8.2 Post Construction Documents	400	hr			$52.50		$0	$0	$21,000	$0	$21,000
Subtotal							$1,804,694	$26,657	$251,545	$130,955	$2,213,851
Local Area Adjustments							100.0%	112.3%	130.4%	130.4%	
							$1,804,694	$29,936	$328,014	$170,765	$2,333,409
Overhead on Labor Cost @ 30%									$98,404		$98,404
G & A on Labor Cost @ 10%									$32,801		$32,801
G & A on Material Cost @ 10%								$2,994			$2,994
G & A on Subcontract Cost @ 10%							$180,469				$180,469

SITE 6A - FUEL CALIBRATION AREA, SITE 10B - ENGINE TEST HOUSE, AND ONSITE SOUTHERN AREA
NWIRP CALVERTON
CALVERTON, NEW YORK
ALT S4: EXCAVATION, ON-SITE TREATMENT (THERMAL), AND ON-SITE RE-USE OF SITES 6A AND 10B SOIL
CAPITAL COST

Item	Quantity	Unit	Unit Cost				Extended Cost				Subtotal
			Subcontract	Material	Labor	Equipment	Subcontract	Material	Labor	Equipment	
G & A on Equipment Cost @	10%									$17,076	$17,076
Total Direct Cost							$1,985,164	$32,929	$459,220	$187,841	$2,665,155
Indirects on Total Direct Cost @	35%		(Total Direct Cost Minus Transportation and Disposal Costs)								$925,152
Profit on Total Direct Cost @	10%										$266,515
Subtotal											$3,856,822
Health & Safety Monitoring @	2%										$77,136
Total Field Cost											$3,933,958
Contingency on Total Field Costs @	25%										$983,490
Engineering on Total Field Cost @	5%										$196,698
TOTAL COST											**$5,114,145**

D.4 - ALTERNATIVE S5

INSTITUTIONAL CONTROLS/DEED NOTIFICATIONS, IN-SITU TREATMENT (SOIL VAPOR EXTRACTION), AND MONITORING

SITE 6A - FUEL CALIBRATION AREA, SITE 10B - ENGINE TEST HOUSE, AND ONSITE SOUTHERN AREA
NWIRP CALVERTON
CALVERTON, NEW YORK
ALT S5: INSTITUTIONAL CONTROLS / DEED NOTIFICATIONS, IN-SITU TREATMENT (SOIL VAPOR EXTRACTION), AND MONITORING
CAPITAL COST

Item	Quantity	Unit	Unit Cost				Extended Cost				Subtotal
			Subcontract	Material	Labor	Equipment	Subcontract	Material	Labor	Equipment	
1 PROJECT PLANNING											
1.1 Prepare Remedial Action Plan	300	hr			$52.50		$0	$0	$15,750	$0	$15,750
1.2 Land Use Controls / Deeds Notifications	150	hr			$52.50		$0	$0	$7,875	$0	$7,875
2 MOBILIZATION/DEMOBILIZATION AND FIELD SUPPORT											
2.1 Office Trailer	5	mo		$202.50			$0	$1,013	$0	$0	$1,013
2.2 Storage Trailer (1)	5	mo		$105.00			$0	$525	$0	$0	$525
2.3 Equipment Mobilization/Demob, Less than 150 HP	2	ea			$55.00	$112.00	$0	$0	$110	$224	$334
2.4 Survey, Pre- and Post-Remediation	8.0	ac	$1,200.00				$9,600	$0	$0	$0	$9,600
2.5 Site Utilities	5	mo	$200.00				$1,000	$0	$0	$0	$1,000
2.6 Electrical Hook-up / Power Source	1	ls	$20,000.00				$20,000	$0	$0	$0	$20,000
3 DECONTAMINATION											
3.1 Temporary Decon Pad	1	ls		$500.00	$450.00	$155.00	$0	$500	$450	$155	$1,105
3.2 Decontamination Services	2	mo		$210.00	$1,800.00	$315.00	$0	$420	$3,600	$630	$4,650
3.3 Decon Water	2,000	gal		$0.20			$0	$400	$0	$0	$400
3.4 Decon Water Storage Tank, 6,000 gallon	2	mo				$645.00	$0	$0	$0	$1,290	$1,290
3.5 Clean Water Storage Tank, 4,000 gallon	2	mo				$580.00	$0	$0	$0	$1,160	$1,160
3.6 Disposal of Decon Waste (Liquid & Solid)	2	mo	$900.00				$1,800	$0	$0	$0	$1,800
4 DEMOLITION											
4.1 Demolition, Site 6A Concrete Pad, 1 ft Thick, Reinforced	320	cy			$50.00	$34.50	$0	$0	$16,000	$11,040	$27,040
4.2 Demolition, Site 10B Concrete Pad, 1 ft Thick, Reinforced	240	cy			$50.00	$34.50	$0	$0	$12,000	$8,280	$20,280
4.3 Shut Off Utilities, Site 10B Building	1	ls	$250.00				$250	$0	$0	$0	$250
4.4 Demolition, Site 10B, Building	3,750	sf	$7.00				$26,250	$0	$0	$0	$26,250
4.5 Building Steel Recycling	25	cy	$0.00				$0	$0	$0	$0	$0
4.6 Concrete Disposal, Pad and Building	575	cy	$29.55				$16,991	$0	$0	$0	$16,991
5 PRE-DESIGN INVESTIGATION											
5.1 Mobilize / Demobilize DPT Rig	1	ls	$3,000.00				$3,000	$0	$0	$0	$3,000
5.2 DPT Drill (2 Samples per Boring), 15 Borings Per Site, 10 ft Deep	300	ft	$20.00				$6,000	$0	$0	$0	$6,000
5.3 Analyze (VOCs, PAHs)	40	ea	$120.00	$5.00	$50.00		$4,800	$200	$2,000	$0	$7,000
6 SITE 6A TRENCH INSTALLATION											
6.1 Install 10 Trenches, Each 500 Ft Long, 4 Ft Deep	5,000	ft			$3.28	$1.36	$0	$0	$16,400	$6,800	$23,200
8.2 Geotextile for Subsurface Drainage	1,667	sy		$1.28	$0.18		$0	$2,133	$300	$0	$2,433
6.3 Gravel Layer, 10 Trenches, Each 500 Ft Long, 6 inches x 1 foot	93	cy		$27.50	$2.47	$4.22	$0	$2,546	$229	$391	$3,166
6.4 2-inch Dia. PVC Piping, Perforated	5,000	ft		$2.57	$3.93	$6.45	$0	$12,870	$19,650	$32,250	$64,770
6.5 Plastic Sheeting, 20 mil, no Seaming	99,700	sf		$0.28	$0.12	$0.05	$0	$27,916	$11,466	$4,487	$43,868
7 SITE 6A SVE SYSTEM INSTALLATION											
7.1 Pilot Scale Testing	1	ls	$15,000.00				$15,000	$0	$0	$0	$15,000
7.2 Building Foundation	500	sf	$4.06				$2,030	$0	$0	$0	$2,030
7.3 Treatment Building	500	sf	$11.58				$5,790	$0	$0	$0	$5,790
7.4 Building Misc. (door/vent/insulation/misc.)	1	ls	$2,080.00				$2,080	$0	$0	$0	$2,080
7.5 Vacuum Pump Package, 900 cfm (15 BHP) at 4" Hg	1	ea		$16,000.00			$0	$16,000	$0	$0	$16,000
7.6 150-gallon Moisture Separator	1	ea		$1,800.00			$0	$1,800	$0	$0	$1,800
7.7 One (1) HP Transfer Pump for Moisture Separator	1	ea		$500.00			$0	$500	$0	$0	$500
7.8 Wastewater Storage Tank, 1000 Gallon	1	ea		$3,500.00			$0	$3,500	$0	$0	$3,500
7.9 Float Switch	1	ea		$300.00			$0	$300	$0	$0	$300
7.10 Pressure Gages	6	ea		$70.00			$0	$420	$0	$0	$420
7.11 Steel Pipe, 2-inch Diameter	50	ft		$4.85	$9.20		$0	$243	$460	$0	$703
7.12 GAC Canister Unit (2 @ 13,600 LB)	2	ea		$62,622.49			$0	$125,245	$0	$0	$125,245
7.13 Electrician, Miscellaneous Electrical	1	ls		$5,000.00	$1,630.00		$0	$5,000	$1,630	$0	$6,630
7.14 Telemetry System	1	ls	$3,000.00				$3,000	$0	$0	$0	$3,000
7.15 Systems Start-up and Testing, 2 People for 2 Weeks	4	mn-wks			$1,500.00		$0	$0	$6,000	$0	$6,000
8 SITE 10B TRENCH INSTALLATION											
8.1 Install 5 Trenches, Each 200 Ft Long, 4 Ft Deep	1,000	ft			$3.28	$1.36	$0	$0	$3,280	$1,360	$4,640
8.2 Geotextile for Subsurface Drainage	333	sy		$1.28	$0.18		$0	$427	$60	$0	$487
8.3 Gravel Layer, 5 Trenches, Each 200 Ft Long, 6 inches x 1 foot	19	cy		$27.50	$2.47	$4.22	$0	$509	$46	$78	$633
8.4 2-inch Dia. PVC Piping, Perforated	1,000	ft		$2.57	$3.93	$6.45	$0	$2,574	$3,930	$6,450	$12,954
8.5 Plastic Sheeting, 20 mil, no Seaming	25,200	sf		$0.28	$0.12	$0.05	$0	$7,056	$2,898	$1,134	$11,088
9 SITE 10B SVE SYSTEM INSTALLATION											
9.1 Pilot Scale Testing	1	ls	$15,000.00				$15,000	$0	$0	$0	$15,000
9.2 Building Foundation	250	sf	$4.06				$1,015	$0	$0	$0	$1,015
9.3 Treatment Building	250	sf	$11.58				$2,895	$0	$0	$0	$2,895
9.4 Building Misc. (door/vent/insulation/misc.)	1	ls	$1,790.00				$1,790	$0	$0	$0	$1,790

SITE 6A - FUEL CALIBRATION AREA, SITE 10B - ENGINE TEST HOUSE, AND ONSITE SOUTHERN AREA
NWIRP CALVERTON
CALVERTON, NEW YORK
ALT S5: INSTITUTIONAL CONTROLS / DEED NOTIFICATIONS, IN-SITU TREATMENT (SOIL VAPOR EXTRACTION), AND MONITORING
CAPITAL COST

Item	Quantity	Unit	Unit Cost				Extended Cost				Subtotal
			Subcontract	Material	Labor	Equipment	Subcontract	Material	Labor	Equipment	
9.5 Vacuum Pump Package, 250 cfm (3 BHP) at 4" Hg	1	ea		$8,500.00			$0	$8,500	$0	$0	$8,500
9.6 80-gallon Moisture Separator	1	ea		$800.00			$0	$800	$0	$0	$800
9.7 One (1) HP Transfer Pump for Moisture Separator	1	ea		$500.00			$0	$500	$0	$0	$500
9.8 Wastewater Storage Tank, 1000 Gallon	1	ea		$3,500.00			$0	$3,500	$0	$0	$3,500
9.9 Float Switch	1	ea		$300.00			$0	$300	$0	$0	$300
9.10 Pressure Gages	4	ea		$70.00			$0	$280	$0	$0	$280
9.11 Steel Pipe, 2-inch Diameter	50	ft		$4.85	$9.20		$0	$243	$460	$0	$703
9.12 GAC Canister Unit (2 @ 13,600 LB)	2	ea		$62,622.49			$0	$125,245	$0	$0	$125,245
9.13 Electrician, Miscellaneous Electrical	1	ls		$5,000.00	$1,630.00		$0	$5,000	$1,630	$0	$6,630
9.14 Telemetry System	1	ls	$3,000.00				$3,000	$0	$0	$0	$3,000
9.15 Systems Start-up and Testing, 2 People for 1 Week	2	mn-wks			$1,500.00		$0	$0	$3,000	$0	$3,000
10 SITE RESTORATION											
10.1 Topsoil, 6 inches Thick	280	cy		$26.30	$0.21	$0.60	$0	$7,364	$59	$168	$7,591
10.2 Subsoil, 6 inches Thick in Concrete Removal Areas	280	cy		$21.74	$0.28	$0.70	$0	$6,087	$78	$196	$6,362
10.3 Fine Grading and Seeding, Incl. Lime, Fert, and Seed	7,600	sy		$0.35	$1.35	$0.22	$0	$2,660	$10,260	$1,672	$14,592
11 AIR MONITORING											
11.1 VOC Air Monitoring, Both Sites, Weekly for One Month	8	ea	$150.00	$5.00	$30.00		$1,200	$40	$240	$0	$1,480
12 MISCELLANEOUS											
12.1 Prepare Post-Construction Documents	200	hours			$52.50		$0	$0	$10,500	$0	$10,500
12.2 Construction Oversight (2p * 20 weeks)	40	mn-wks			$2,000.00		$0	$0	$80,000	$0	$80,000
Subtotal Direct Costs							$142,491	$372,615	$230,360	$77,764	$823,231
Local Area Adjustments							100.0%	112.3%	130.4%	130.4%	
							$142,491	$418,447	$300,390	$101,405	$962,733
Overhead on Labor Cost @ 30%									$90,117		$90,117
G & A on Labor Cost @ 10%									$30,039		$30,039
G & A on Material Cost @ 10%								$41,845			$41,845
G & A on Subcontract Cost @ 10%							$14,249				$14,249
G & A on Equipment Cost @ 10%										$10,140	$10,140
Total Direct Cost							$156,740	$460,292	$420,545	$111,545	$1,149,123
Indirects on Total Direct Cost @ 35%			(Total Direct Cost Minus Transportation and Disposal Costs)								$395,616
Profit on Total Direct Cost @ 10%											$114,912
Subtotal											$1,659,651
Health & Safety Monitoring @ 2%											$33,193
Total Field Cost											$1,692,844
Contingency on Total Field Costs @ 25%											$423,211
Engineering on Total Field Cost @ 15%											$253,927
TOTAL COST											**$2,369,982**

SITE 6A - FUEL CALIBRATION AREA, SITE 10B - ENGINE TEST HOUSE, AND ONSITE SOUTHERN AREA
NWIRP CALVERTON
CALVERTON, NEW YORK
ALT S5: INSTITUTIONAL CONTROLS / DEED NOTIFICATIONS, IN-SITU TREATMENT (SOIL VAPOR EXTRACTION), AND MONITORING
OPERATION AND MAINTENANCE COSTS PER YEAR

	Item	Qty	Unit	Unit Cost	Subtotal Cost	Notes
	Site 6A					
	Year 1					
1	Energy - Electric	98,373	kWh	$0.12	$11,805	
2	Maintenance	1	ls	$8,204.87	$8,205	5% of Installation Cost
3	Labor	52	wk	$240.00	$12,480	1 visit per week - 1/2 day
4	Changeout of Spent Carbon	27,217	pound	$3.00	$81,651	6 replacements during Year 1
5	Cartridge-Type Filters, for Pumps	4	ea	$50.00	$200	
6	Quarterly Reports	4	ea	$4,000.00	$16,000	
	Subtotal Cost per Year of Operation				$130,341	
	Years 2 through 3					
1	Energy - Electric	98,373	kWh	$0.12	$11,805	
2	Maintenance	1	ls	$8,204.87	$8,205	5% of Installation Cost
3	Labor	52	wk	$240.00	$12,480	1 visit per week - 1/2 day
4	Changeout of Spent Carbon	13,600	pound	$3.00	$40,800	1 replacement per year, Years 2 & 3
5	Cartridge-Type Filters, for Pumps	4	ea	$50.00	$200	
6	Quarterly Reports	4	ea	$4,000.00	$16,000	
	Subtotal Cost per Year of Operation				$89,490	
	Year 4					
1	Energy - Electric	98,373	kWh	$0.12	$11,805	
2	Maintenance	1	ls	$8,204.87	$8,205	5% of Installation Cost
3	Labor	52	wk	$240.00	$12,480	1 visit per week - 1/2 day
4	Changeout of Spent Carbon	13,600	pound	$3.00	$40,800	1 replacement per year, Year 4
5	Cartridge-Type Filters, for Pumps	4	ea	$50.00	$200	
6	Quarterly Reports	4	ea	$4,000.00	$16,000	
	Subtotal Cost per Year of Operation				$89,490	

SITE 6A - FUEL CALIBRATION AREA, SITE 10B - ENGINE TEST HOUSE, AND ONSITE SOUTHERN AREA
NWIRP CALVERTON
CALVERTON, NEW YORK
ALT S5: INSTITUTIONAL CONTROLS / DEED NOTIFICATIONS, IN-SITU TREATMENT (SOIL VAPOR EXTRACTION), AND MONITORING
OPERATION AND MAINTENANCE COSTS PER YEAR

	Item	Qty	Unit	Unit Cost	Subtotal Cost	Notes
	Site 10B					
	Year 1					
1	Energy - Electric	19,985	kWh	$0.12	$2,398	
2	Maintenance	1	ls	$7,622.87	$7,623	5% of Installation Cost
3	Labor	52	wk	$240.00	$12,480	1 visit per week - 1/2 day
4	Changeout of Spent Carbon	13,600	pound	$3.00	$40,800	1 replacement during Year 1
5	Cartridge-Type Filters, for Pumps	4	ea	$50.00	$200	
6	Quarterly Reports	4	ea	$4,000.00	$16,000	
	Subtotal Cost per Year of Operation				$79,501	
	Year 2					
1	Energy - Electric	19,985	kWh	$0.12	$2,398	
2	Maintenance	1	ls	$7,622.87	$7,623	5% of Installation Cost
3	Labor	52	wk	$240.00	$12,480	1 visit per week - 1/2 day
4	Changeout of Spent Carbon	13,600	pound	$3.00	$40,800	1 replacement during Year 2
5	Cartridge-Type Filters, for Pumps	4	ea	$50.00	$200	
6	Quarterly Reports	4	ea	$4,000.00	$16,000	
	Subtotal Cost per Year of Operation				$79,501	
	Years 3 and 4					
1	Energy - Electric	19,985	kWh	$0.12	$2,398	
2	Maintenance	1	ls	$7,622.87	$7,623	5% of Installation Cost
3	Labor	52	wk	$240.00	$12,480	1 visit per week - 1/2 day
4	Changeout of Spent Carbon	13,600	pound	$3.00	$40,800	1 replacement during Years 3 & 4
5	Cartridge-Type Filters, for Pumps	4	ea	$50.00	$200	
6	Quarterly Reports	4	ea	$4,000.00	$16,000	
	Subtotal Cost per Year of Operation				$79,501	

SITE 6A - FUEL CALIBRATION AREA, SITE 10B - ENGINE TEST HOUSE, AND ONSITE SOUTHERN AREA
NWIRP CALVERTON
CALVERTON, NEW YORK
ALT S5: INSTITUTIONAL CONTROLS / DEED NOTIFICATIONS, IN-SITU TREATMENT (SOIL VAPOR EXTRACTION), AND MONITORING
ANNUAL GROUNDWATER SAMPLING COST

Item	Item Cost Years 1 through 4	Item Cost Years 5 through 30	Item Cost Every 5 Years	Notes
Sampling/Soil	$6,050			DPT Rig and Labor, 4 Samples per Year per Site, Sites 6A & 10B
Analysis/Soil	$6,960			Analyze Samples for VOCs, SVOCs, PBCs, PAHs, and TPH-DRO; 4 Samples per Year per Site, Sites 6A & 10B
Sampling/Air	$2,880			Labor, One Day per Month
Analysis/Air	$3,600			Monthly, Tedlar Bags, 2 Sites
Sampling/Soil			$5,250	DPT Rig and Labor, 4 Samples per Year, Site 6A
Analysis/Soil			$390	Analyze Samples for PBCs; 4 Samples per Year, Site 6A
Inspections	$1,000	$1,000		Annual LUC Inspection
Report	$10,000			Document sampling events and results annually.
5-Year Review Report			$23,000	
TOTALS	$30,490	$1,000	$28,640	

SITE 6A - FUEL CALIBRATION AREA, SITE 10B - ENGINE TEST HOUSE, AND ONSITE SOUTHERN AREA
NWIRP CALVERTON
CALVERTON, NEW YORK
ALT S5: INSTITUTIONAL CONTROLS / DEED NOTIFICATIONS, IN-SITU TREATMENT (SOIL VAPOR EXTRACTION), AND MONITORING
PRESENT WORTH ANALYSIS

Year	Capital Cost	Operation & Maintenance Cost	Annual Cost	Total Year Cost	Annual Discount Rate at 7%	Present Worth
0	$2,369,982			$2,369,982	1.000	$2,369,982
1		$209,842	$30,490	$240,332	0.935	$224,710
2		$168,991	$30,490	$199,481	0.873	$174,147
3		$168,991	$30,490	$199,481	0.816	$162,776
4		$168,991	$30,490	$199,481	0.763	$152,204
5			$29,640	$29,640	0.713	$21,133
6			$1,000	$1,000	0.666	$666
7			$1,000	$1,000	0.623	$623
8			$1,000	$1,000	0.582	$582
9			$1,000	$1,000	0.544	$544
10			$29,640	$29,640	0.508	$15,057
11			$1,000	$1,000	0.475	$475
12			$1,000	$1,000	0.444	$444
13			$1,000	$1,000	0.415	$415
14			$1,000	$1,000	0.388	$388
15			$29,640	$29,640	0.362	$10,730
16			$1,000	$1,000	0.339	$339
17			$1,000	$1,000	0.317	$317
18			$1,000	$1,000	0.296	$296
19			$1,000	$1,000	0.277	$277
20			$29,640	$29,640	0.258	$7,647
21			$1,000	$1,000	0.242	$242
22			$1,000	$1,000	0.226	$226
23			$1,000	$1,000	0.211	$211
24			$1,000	$1,000	0.197	$197
25			$29,640	$29,640	0.184	$5,454
26			$1,000	$1,000	0.172	$172
27			$1,000	$1,000	0.161	$161
28			$1,000	$1,000	0.150	$150
29			$1,000	$1,000	0.141	$141
30			$29,640	$29,640	0.131	$3,883
					TOTAL PRESENT WORTH	$3,154,588

D.5 - ALTERNATIVE S6

INSTITUTIONAL CONTROLS/DEED NOTIFICATIONS AND EXCAVATION OF PCB-CONTAMINATED HOT SPOTS AND OFF-SITE TREATMENT/DISPOSAL

SITE 6A - FUEL CALIBRATION AREA, SITE 10B - ENGINE TEST HOUSE, AND ONSITE SOUTHERN AREA
NWIRP CALVERTON
CALVERTON, NEW YORK
ALTERNATIVE S6: INSTITUTIONAL CONTROLS/DEED NOTIFICATIONS AND EXCAVATION OF PCB-CONTAMINATED HOT SPOTS AND OFF-SITE TREATMENT/DISPOSAL
CAPITAL COST

Item	Quantity	Unit	Unit Cost				Extended Cost				Subtotal
			Subcontract	Material	Labor	Equipment	Subcontract	Material	Labor	Equipment	
1 PROJECT PLANNING											
1.1 Prepare Remedial Action Plan	240	hr			$52.50		$0	$0	$12,600	$0	$12,600
1.2 Land Use Controls/Deeds Notifications	150	hr			$52.50		$0	$0	$7,875	$0	$7,875
2 MOBILIZATION/DEMOBILIZATION AND FIELD SUPPORT											
2.1 Office Trailer	2	mo		$202.50			$0	$405	$0	$0	$405
2.2 Storage Trailer	2	mo		$105.00			$0	$210	$0	$0	$210
2.3 Survey, Pre- and Post-Remediation	8.0	ac	$1,200.00				$9,600	$0	$0	$0	$9,600
2.4 Equipment Mobilization/Demob, Less than 150 HP	2	ea			$55.00	$112.00	$0	$0	$110	$224	$334
2.5 Equipment Mobilization/Demob, Greater than 150 HP	2	ea			$73.00	$175.00	$0	$0	$146	$350	$496
2.6 Site Utilities	2	mo		$427.00			$0	$854	$0	$0	$854
2.7 Truck Scale	2	mo				$3,100.00	$0	$0	$0	$6,200	$6,200
3 DECONTAMINATION											
3.1 Equipment Decon Pad	1	ls		$5,800.00	$6,650.00	$700.00	$0	$5,800	$6,650	$700	$13,150
3.2 Decontamination Services	1	mo		$210.00	$1,800.00	$315.00	$0	$210	$1,800	$315	$2,325
3.3 Decon Water	1,000	gal		$0.20			$0	$200	$0	$0	$200
3.4 Decon Water Storage Tank, 4,000 gallon	1	mo				$580.00	$0	$0	$0	$580	$580
3.5 Clean Water Storage Tank, 4,000 gallon	1	mo				$580.00	$0	$0	$0	$580	$580
3.6 Disposal of Decon Waste (Liquid & Solid)	1	mo	$900.00				$900	$0	$0	$0	$900
4 PRE-DESIGN INVESTIGATION											
4.1 Mobilize / Demobilize DPT Rig	1	ls	$3,000.00				$3,000	$0	$0	$0	$3,000
4.2 DPT Drill (2 Samples per Boring), 15 Borings Per Site, 10 ft Deep	300	ft	$20.00				$6,000	$0	$0	$0	$6,000
4.3 Analyze (PCBs)	4	ea	$200.00	$5.00	$50.00		$800	$20	$200	$0	$1,020
5 EXCAVATION											
5.1 Excavator, 1 CY	1	mo			$6,031.20	$9,677.80	$0	$0	$6,031	$9,678	$15,709
5.2 Front End Loader, 3 CY	1	mo			$5,821.20	$6,737.00	$0	$0	$5,821	$6,737	$12,558
5.3 Lined Gravel Pad to Drain Free Product from Soil	250	sf	$3.42	$3.98	$2.23	$0.59	$855	$995	$558	$148	$2,555
5.4 Pump, 2 inch, Centrifugal	1	mo				$921.00	$0	$0	$0	$921	$921
5.5 Polyethylene Tank	1	mo	$735.00				$735	$0	$0	$0	$735
5.6 Disposal of Free Product	23	gal	$2.85				$66	$0	$0	$0	$66
5.7 Disposal of Water Drained from Excavated Soil	2,000	gal	$0.20				$400	$0	$0	$0	$400
5.8 Confirmation Test (VOCs, SVOCs, PAHs, Pest/PCBs, & DRO)	24	ea	$200.00	$5.00	$50.00	$10.00	$4,800	$120	$1,200	$240	$6,360
6 DISPOSAL											
6.1 Waste Characterization Testing (TCLP)	2	ea	$785.00	$5.00	$30.00		$1,570	$10	$60	$0	$1,640
6.2 Hazardous Soil Transportation and Disposal, Site 6A	23	tons	$245.50				$5,647	$0	$0	$0	$5,647
6.3 Non-Hazardous Soil Transportation and Disposal Site 6A	600	tons	$97.03				$58,218	$0	$0	$0	$58,218
7 SITE RESTORATION											
7.1 Topsoil, 6 inches Thick	85	cy		$26.30	$0.21	$0.60	$0	$2,236	$18	$51	$2,304
7.2 Subsoil	325	cy		$21.74	$0.28	$0.70	$0	$7,066	$91	$228	$7,384
7.3 Fine Grading and Seeding, Incl. Lime, Fert, and Seed	510	sy		$0.35	$1.35	$0.22	$0	$179	$689	$112	$979
8 MISCELLANEOUS											
8.1 Construction Oversite (3p * 1 month)	63	mn-days			$240.00		$0	$0	$15,120	$0	$15,120
8.2 Post Construction Documents	50	hr			$52.50		$0	$0	$2,625	$0	$2,625
Subtotal							$92,590	$18,304	$61,593	$27,063	$199,550
Local Area Adjustments							100.0%	112.3%	130.4%	130.4%	
							$92,590	$20,555	$80,318	$35,290	$228,753
Overhead on Labor Cost @	30%								$24,095		$24,095
G & A on Labor Cost @	10%								$8,032		$8,032
G & A on Material Cost @	10%							$2,055			$2,055
G & A on Subcontract Cost @	10%						$9,259				$9,259
G & A on Equipment Cost @	10%									$3,529	$3,529

SITE 6A - FUEL CALIBRATION AREA, SITE 10B - ENGINE TEST HOUSE, AND ONSITE SOUTHERN AREA
NWIRP CALVERTON
CALVERTON, NEW YORK
ALTERNATIVE S6: INSTITUTIONAL CONTROLS/DEED NOTIFICATIONS AND EXCAVATION OF PCB-CONTAMINATED HOT SPOTS AND OFF-SITE TREATMENT/DISPOSAL
CAPITAL COST

Item	Quantity	Unit	Unit Cost				Extended Cost				Subtotal
			Subcontract	Material	Labor	Equipment	Subcontract	Material	Labor	Equipment	
Total Direct Cost							$101,849	$22,610	$112,445	$38,819	$275,723
Indirects on Total Direct Cost @	35%		(Total Direct Cost Minus Transportation and Disposal Costs)								$73,673
Profit on Total Direct Cost @	10%										$27,572
Subtotal											$376,968
Health & Safety Monitoring @	2%										$7,539
Total Field Cost											$384,507
Contingency on Total Field Costs @	25%										$96,127
Engineering on Total Field Cost @	15%										$57,676
TOTAL COST											**$538,310**

SITE 6A - FUEL CALIBRATION AREA, SITE 10B - ENGINE TEST HOUSE, AND ONSITE SOUTHERN AREA
NWIRP CALVERTON
CALVERTON, NEW YORK
ALTERNATIVE S6: INSTITUTIONAL CONTROLS/DEED NOTIFICATIONS AND EXCAVATION OF PCB-CONTAMINATED HOT SPOTS AND OFF-SITE TREATMENT/DISPOSAL
ANNUAL COST

Item	Item Cost Annually	Item Cost Every 5 Years	Notes
Soil Sampling		$6,050	DPT Rig and Labor for 8 Soil Samples (4 per Site) Every 5 Years
Soil Analytical		$6,188	8 Soil Samples (4 per Site) Every 5 Years, Analyzed for VOCs, SVOCs, PAHs, & DRO
Inspection	$1,000		Annual LUC inspection (assume 8 hours at $50/hr plus expenses)
5-Year Site Review		$23,000	
TOTALS	$1,000	$35,238	

SITE 6A - FUEL CALIBRATION AREA, SITE 10B - ENGINE TEST HOUSE, AND ONSITE SOUTHERN AREA
NWIRP CALVERTON
CALVERTON, NEW YORK
ALTERNATIVE S6: INSTITUTIONAL CONTROLS/DEED NOTIFICATIONS AND EXCAVATION OF PCB-CONTAMINATED HOT SPOTS AND OFF-SITE TREATMENT/DISPOSAL
PRESENT WORTH ANALYSIS

Year	Capital Cost	Annual Cost	Total Year Cost	Annual Discount Rate at 7%	Present Worth
0	$538,310		$538,310	1.000	$538,310
1		$1,000	$1,000	0.935	$935
2		$1,000	$1,000	0.873	$873
3		$1,000	$1,000	0.816	$816
4		$1,000	$1,000	0.763	$763
5		$36,238	$36,238	0.713	$25,838
6		$1,000	$1,000	0.666	$666
7		$1,000	$1,000	0.623	$623
8		$1,000	$1,000	0.582	$582
9		$1,000	$1,000	0.544	$544
10		$36,238	$36,238	0.508	$18,409
11		$1,000	$1,000	0.475	$475
12		$1,000	$1,000	0.444	$444
13		$1,000	$1,000	0.415	$415
14		$1,000	$1,000	0.388	$388
15		$36,238	$36,238	0.362	$13,118
16		$1,000	$1,000	0.339	$339
17		$1,000	$1,000	0.317	$317
18		$1,000	$1,000	0.296	$296
19		$1,000	$1,000	0.277	$277
20		$36,238	$36,238	0.258	$9,349
21		$1,000	$1,000	0.242	$242
22		$1,000	$1,000	0.226	$226
23		$1,000	$1,000	0.211	$211
24		$1,000	$1,000	0.197	$197
25		$36,238	$36,238	0.184	$6,668
26		$1,000	$1,000	0.172	$172
27		$1,000	$1,000	0.161	$161
28		$1,000	$1,000	0.150	$150
29		$1,000	$1,000	0.141	$141
30		$36,238	$36,238	0.131	$4,747
				TOTAL PRESENT WORTH	$626,693

D.6 - ALTERNATIVE S7
EXCAVATION OF PCB-CONTAMINATED HOT SPOTS AND OFF-SITE TREATMENT/DISPOSAL AND IN-SITU TREATMENT OF PETROLEUM- AND SOLVENT-CONTAMINATED SOIL BY ISCO

SITE 6A - FUEL CALIBRATION AREA, SITE 10B - ENGINE TEST HOUSE, AND ONSITE SOUTHERN AREA
NWIRP CALVERTON
CALVERTON, NEW YORK
ALT S7: EXCAVATION OF PCB-CONTAMINATED HOT SPOTS AND OFF-SITE TREATMENT/DISPOSAL AND IN-SITU TREATMENT OF PETROLEUM- AND SOLVENT-CONTAMINATED SOIL BY ISCO
CAPITAL COST - EXCAVATION

Item	Quantity	Unit	Unit Cost				Extended Cost				Subtotal
			Subcontract	Material	Labor	Equipment	Subcontract	Material	Labor	Equipment	
1 PROJECT PLANNING											
1.1 Prepare Remedial Action Plan	160	hr			$52.50		$0	$0	$8,400	$0	$8,400
2 MOBILIZATION/DEMOBILIZATION AND FIELD SUPPORT											
2.1 Office Trailer	2	mo		$202.50			$0	$405	$0	$0	$405
2.2 Storage Trailer	2	mo		$105.00			$0	$210	$0	$0	$210
2.3 Survey, Pre- and Post-Remediation	8.0	ac	$1,200.00				$9,600	$0	$0	$0	$9,600
2.4 Equipment Mobilization/Demob, less than 150 H.P.	2	ea			$55.00	$112.00	$0	$0	$110	$224	$334
2.5 Equipment Mobilization/Demob, greater than 150 H.P.	2	ea			$73.00	$175.00	$0	$0	$146	$350	$496
2.6 Site Utilities	2	mo		$427.00			$0	$854	$0	$0	$854
2.7 Truck Scale	2	mo				$3,100.00	$0	$0	$0	$6,200	$6,200
3 DECONTAMINATION											
3.1 Equipment Decon Pad	1	ls		$5,800.00	$6,650.00	$700.00	$0	$5,800	$6,650	$700	$13,150
3.2 Decontamination Services	1	mo		$210.00	$1,800.00	$315.00	$0	$210	$1,800	$315	$2,325
3.3 Decon Water	1,000	gal		$0.20			$0	$200	$0	$0	$200
3.4 Decon Water Storage Tank, 4,000 gallon	1	mo				$580.00	$0	$0	$0	$580	$580
3.5 Clean Water Storage Tank, 4,000 gallon	1	mo				$580.00	$0	$0	$0	$580	$580
3.6 Disposal of Decon Waste (liquid & solid)	1	mo	$900.00				$900	$0	$0	$0	$900
4 PRE-DESIGN INVESTIGATION											
4.1 Mobilize / Demobilize DPT Rig	1	ls	$3,000.00				$3,000	$0	$0	$0	$3,000
4.2 DPT Drill (2 Samples per Boring), 15 Borings Per Site, 10 ft Deep	300	ft	$20.00				$6,000	$0	$0	$0	$6,000
4.3 Analyze (DRO, PCBs, PAHs, VOCs)	16	ea	$500.00	$5.00	$50.00		$8,000	$80	$800	$0	$8,880
5 EXCAVATION											
5.1 Excavator, 1 CY	1	mo			$6,031.20	$9,677.80	$0	$0	$6,031	$9,678	$15,709
5.2 Front End Loader, 3 CY	1	mo			$5,821.20	$6,737.00	$0	$0	$5,821	$6,737	$12,558
5.3 Lined Gravel Pad to Drain Free Product from Soil	250	sf	$3.42	$3.98	$2.23	$0.59	$855	$995	$558	$148	$2,555
5.4 Pump, 2 inch, Centrifugal	1	mo				$921.00	$0	$0	$0	$921	$921
5.5 Polyethylene Tank	1	mo	$735.00				$735	$0	$0	$0	$735
5.6 Disposal of Free Product	23	gal	$2.85				$66	$0	$0	$0	$66
5.7 Disposal of Water Drained from Excavated Soil	2,000	gal	$0.20				$400	$0	$0	$0	$400
5.8 Confirmation Test (VOCs, SVOCs, PCBs)	24	ea	$600.00	$5.00	$50.00	$10.00	$14,400	$120	$1,200	$240	$15,960
6 DISPOSAL											
6.1 Waste Characterization Testing (TCLP)	2	ea	$785.00	$5.00	$30.00		$1,570	$10	$60	$0	$1,640
6.2 Hazardous Soil Transportation and Disposal, Site 6A	23	tons	$245.50				$5,647	$0	$0	$0	$5,647
6.3 Non-Hazardous Soil Transportation and Disposal Site 6A	600	tons	$97.03				$58,218	$0	$0	$0	$58,218
7 SITE RESTORATION											
7.1 Topsoil, 6 inches Thick	85	cy		$26.30	$0.21	$0.60	$0	$2,236	$18	$51	$2,304
7.2 Subsoil	325	cy		$21.74	$0.28	$0.70	$0	$7,066	$91	$228	$7,384
7.3 Fine Grading and seeding, incl. lime, fert, and seed	510	sy		$0.35	$1.35	$0.22	$0	$179	$689	$112	$979
8 MISCELLANEOUS											
8.1 Construction Oversite (3p*1 month)	63	mn-days			$240.00		$0	$0	$15,120	$0	$15,120
8.2 Post Construction Documents	50	hr			$52.50		$0	$0	$2,625	$0	$2,625
Subtotal							$109,390	$18,364	$50,118	$27,063	$204,935
Local Area Adjustments							100.0%	112.3%	130.4%	130.4%	
							$109,390	$20,622	$65,354	$35,290	$230,657
Overhead on Labor Cost @ 30%									$19,606		$19,606
G & A on Labor Cost @ 10%									$6,535		$6,535
G & A on Material Cost @ 10%								$2,062			$2,062
G & A on Subcontract Cost @ 10%							$10,939				$10,939
G & A on Equipment Cost @ 10%										$3,529	$3,529

SITE 6A - FUEL CALIBRATION AREA, SITE 10B - ENGINE TEST HOUSE, AND ONSITE SOUTHERN AREA
NWIRP CALVERTON
CALVERTON, NEW YORK
ALT S7: EXCAVATION OF PCB-CONTAMINATED HOT SPOTS AND OFF-SITE TREATMENT/DISPOSAL AND IN-SITU TREATMENT OF PETROLEUM- AND SOLVENT-CONTAMINATED SOIL BY ISCO
CAPITAL COST - EXCAVATION

Item	Quantity	Unit	Unit Cost				Extended Cost				Subtotal
			Subcontract	Material	Labor	Equipment	Subcontract	Material	Labor	Equipment	
Total Direct Cost							$120,329	$22,684	$91,496	$38,819	$273,329
Indirects on Total Direct Cost @ 35%			(Total Direct Cost Minus Transportation and Disposal Costs)								$72,834
Profit on Total Direct Cost @ 10%											$27,333
Subtotal											$373,496
Health & Safety Monitoring @ 2%											$7,470
Total Field Cost											$380,966
Contingency on Total Field Costs @ 25%											$95,241
Engineering on Total Field Cost @ 15%											$57,145
TOTAL COST											**$533,352**

SITE 6A - FUEL CALIBRATION AREA, SITE 10B - ENGINE TEST HOUSE, AND ONSITE SOUTHERN AREA
NWIRP CALVERTON
CALVERTON, NEW YORK
ALT S7: EXCAVATION OF PCB-CONTAMINATED HOT SPOTS AND OFF-SITE TREATMENT/DISPOSAL AND IN-SITU TREATMENT OF PETROLEUM- AND SOLVENT-CONTAMINATED SOIL BY ISCO
REGENOX (THREE APPLICATIONS)

Item	Quantity	Unit	Unit Cost				Extended Cost				Subtotal
			Subcontract	Material	Labor	Equipment	Subcontract	Material	Labor	Equipment	
1 PROJECT PLANNING											
1.1 Prepare Remedial Action Plan	400	hr			$52.50		$0	$0	$21,000	$0	$21,000
1.2 Bench-Scale Treatability Study	1	ls		$3,750.00	$7,500.00	$3,750.00	$0	$3,750	$7,500	$3,750	$15,000
1.3 Pilot Study	1	ls	$6,000.00	$294,000.00			$6,000	$294,000	$0	$0	$300,000
2 MOBILIZATION/DEMOBILIZATION AND FIELD SUPPORT											
2.1 Office Trailer	8	mo		$202.50			$0	$1,620	$0	$0	$1,620
2.2 Storage Trailer	8	mo		$105.00			$0	$840	$0	$0	$840
2.3 Construction Survey	8	ac	$1,200.00				$9,600	$0	$0	$0	$9,600
2.4 DPT Rig Mobilization/Demobilization	2	ea	$3,000.00				$6,000	$0	$0	$0	$6,000
2.5 Site Utilities	8	mo		$427.00			$0	$3,416	$0	$0	$3,416
3 DECONTAMINATION											
3.1 Temporary Decon Pad	1	ls		$500.00	$450.00	$155.00	$0	$500	$450	$155	$1,105
3.2 Decontamination Services	5	mo		$210.00	$1,800.00	$315.00	$0	$1,050	$9,000	$1,575	$11,625
3.3 Decon Water	5,000	gal		$0.20			$0	$1,000	$0	$0	$1,000
3.4 Decon Water Storage Tank, 6,000 gallon	5	mo				$645.00	$0	$0	$0	$3,225	$3,225
3.5 Clean Water Storage Tank, 4,000 gallon	5	mo				$580.00	$0	$0	$0	$2,900	$2,900
3.6 Disposal of Decon Waste (liquid & solid)	5	mo	$900.00				$4,500	$0	$0	$0	$4,500
4 FIRST REGENOX™ INJECTION											
4.1 Injection (50 x 20 points @ 7' deep)	30	day	$2,000.00				$60,000	$0	$0	$0	$60,000
4.2 RegenOx™ Material	4,739,820	lb		$1.84			$0	$8,721,269	$0	$0	$8,721,269
4.3 Waste/Soil Disposal	1	ls	$5,000.00				$5,000	$0	$0	$0	$5,000
5 SECOND REGENOX™ INJECTION											
5.1 Injection (50 x 20 points @ 7' deep)	30	day	$2,000.00				$60,000	$0	$0	$0	$60,000
5.2 RegenOx™ Material	1,930,200	lb		$1.84			$0	$3,551,568	$0	$0	$3,551,568
5.3 Waste/Soil Disposal	1	ls	$4,000.00				$4,000	$0	$0	$0	$4,000
6 THIRD REGENOX™ INJECTION											
6.1 Injection (50 x 20 points @ 7' deep)	25	day	$2,000.00				$50,000	$0	$0	$0	$50,000
6.2 RegenOx™ Material	792,660	lb		$1.84			$0	$1,458,494	$0	$0	$1,458,494
6.3 Waste/Soil Disposal	1	ls	$3,000.00				$3,000	$0	$0	$0	$3,000
7 CONFIRMATION SOIL SAMPLING											
7.1 DPT Drill (2 Samples/Boring), 15 Borings/Site, 10 ft Deep, 2 Rounds	300	ft	$20.00				$6,000	$0	$0	$0	$6,000
7.2 Analyze VOCs, SVOCs, PAHs, and DRO	60	ea	$773.50	$5.00	$50.00		$46,410	$300	$3,000	$0	$49,710
8 AIR MONITORING											
8.1 Collect Air Samples and Analyze	12	mo	$300.00		$240.00		$3,600	$0	$2,880	$0	$6,480
9 MISCELLANEOUS											
9.1 Prepare Post-Construction Documents	600	hours			$52.50		$0	$0	$31,500	$0	$31,500
9.2 Construction Oversight (2p*5 months)	210	mn-days			$240.00		$0	$0	$50,400	$0	$50,400
9.3 DPT Drill (2 Samples per Boring), 15 Borings Per Site, 10 ft Deep											
Subtotal							$264,110	$14,037,807	$125,730	$11,605	$14,439,252
Local Area Adjustments							100.0%	112.3%	130.4%	130.4%	
							$264,110	$15,764,457	$163,952	$15,133	$16,207,652
Overhead on Labor Cost @ 30%									$49,186		$49,186
G & A on Labor Cost @ 10%									$16,395		$16,395
G & A on Material Cost @ 10%								$1,576,446			$1,576,446
G & A on Subcontract Cost @ 10%							$26,411				$26,411
G & A on Equipment Cost @ 10%										$1,513	$1,513
Total Direct Cost							$290,521	$17,340,903	$229,533	$16,646	$17,877,603
Indirects on Total Direct Cost @ 25%			(Total Direct Cost Minus Transportation and Disposal Costs)								$4,465,276
Profit on Total Direct Cost @ 10%											$1,787,760
Subtotal											$24,130,639

SITE 6A - FUEL CALIBRATION AREA, SITE 10B - ENGINE TEST HOUSE, AND ONSITE SOUTHERN AREA
NWIRP CALVERTON
CALVERTON, NEW YORK
ALT S7: EXCAVATION OF PCB-CONTAMINATED HOT SPOTS AND OFF-SITE TREATMENT/DISPOSAL AND IN-SITU TREATMENT OF PETROLEUM- AND SOLVENT-CONTAMINATED SOIL BY ISCO REGENOX (THREE APPLICATIONS)

Item	Quantity	Unit	Unit Cost				Extended Cost				Subtotal
			Subcontract	Material	Labor	Equipment	Subcontract	Material	Labor	Equipment	
Health & Safety Monitoring @	1%										$241,306
Total Field Cost											$24,371,946
Contingency on Total Field Costs @	25%										$6,092,986
Engineering on Total Field Cost @	5%										$1,218,597
TOTAL COST											**$31,683,529**

D.7 - ALTERNATIVE SAGW2
LAND USE CONTROLS/DEED NOTIFICATIONS, NATURAL ATTENUATION, AND MONITORING

SITE 6A - FUEL CALIBRATION AREA, SITE 10B - ENGINE TEST HOUSE, AND ONSITE SOUTHERN AREA
NWIRP CALVERTON
CALVERTON, NEW YORK
ALT SAGW2: LAND USE CONTROLS / DEED NOTIFICATIONS, NATURAL ATTENTUATION, AND MONITORING
CAPITAL COST

Item	Quantity	Unit	Unit Cost				Extended Cost				Subtotal
			Subcontract	Material	Labor	Equipment	Subcontract	Material	Labor	Equipment	
1 PROJECT PLANNING											
1.1 Prepare Remedial Action Plan	100	hr			$52.50		$0	$0	$5,250	$0	$5,250
1.2 Land Use Controls / Deed Notifications	150	hr			$52.50		$0	$0	$7,875	$0	$7,875
2 MOBILIZATION/DEMOBILIZATION AND SURVEY											
2.1 Construction Survey	1	ls	$1,000.00				$1,000	$0	$0	$0	$1,000
2.2 Drill Rig Mobilization/Demobilization	1	ls	$5,000.00				$5,000	$0	$0	$0	$5,000
3 SITE 6A MONITORING WELL INSTALLATION											
3.1 Install Monitoring Wells, 2 wells, 30 ft each	60	ft	$35.00				$2,100	$0	$0	$0	$2,100
3.2 Flushmounts	2	ea	$120.00				$240	$0	$0	$0	$240
3.3 Collect/Containerize IDW	2	ea	$50.00				$100	$0	$0	$0	$100
3.4 Transport/Dispose IDW Off Site	2	drums	$150.00				$300	$0	$0	$0	$300
4 SITE 10B MONITORING WELL INSTALLATION											
4.1 Install Monitoring Wells, 4 wells, 30 ft each	120	ft	$35.00				$4,200	$0	$0	$0	$4,200
4.2 Flushmounts	4	ea	$120.00				$480	$0	$0	$0	$480
4.3 Collect/Containerize IDW	4	ea	$50.00				$200	$0	$0	$0	$200
4.4 Transport/Dispose IDW Off Site	4	drums	$150.00				$600	$0	$0	$0	$600
5 MISCELLANEOUS											
5.1 Prepare Post-Construction Documents	20	hours			$52.50		$0	$0	$1,050	$0	$1,050
5.2 Construction Oversight (2p * 2week)	4	mn-wks			$1,200.00		$0	$0	$28,800	$0	$28,800
Subtotal							$14,220	$0	$42,975	$0	$57,195
Local Area Adjustments							100.0%	112.3%	130.4%	130.4%	
							$14,220	$0	$56,039	$0	$70,259
Overhead on Labor Cost @ 30%									$16,812		$16,812
G & A on Labor Cost @ 10%									$5,604		$5,604
G & A on Material Cost @ 10%								$0			$0
G & A on Subcontract Cost @ 10%							$1,422				$1,422
G & A on Equipment Cost @ 10%										$0	$0
Total Direct Cost							$15,642	$0	$78,455	$0	$94,097
Indirects on Total Direct Cost @ 35%			(Total Direct Cost Minus Transportation and Disposal Costs)								$32,619
Profit on Total Direct Cost @ 10%											$9,410
Subtotal											$136,126
Health & Safety Monitoring @ 2%											$2,723
Total Field Cost											$138,848
Contingency on Total Field Costs @ 15%											$20,827
Engineering on Total Field Cost @ 15%											$20,827
TOTAL COST											**$180,503**

SITE 6A - FUEL CALIBRATION AREA, SITE 10B - ENGINE TEST HOUSE, AND ONSITE SOUTHERN AREA
NWIRP CALVERTON
CALVERTON, NEW YORK
ALT SAGW2: LAND USE CONTROLS / DEED NOTIFICATIONS, NATURAL ATTENTUATION, AND MONITORING
ANNUAL COST

Item	Item Cost Year 1	Item Cost Years 2 through 10	Item Cost Years 11 through 30	Item Cost Every 5 Years	Notes
Quarterly Groundwater Sampling	$14,520				8 Wells at Site 6A plus 4 Wells at Site 10B, 4 times, Labor
Quarterly Groundwater Analysis	$44,208				8 Wells at Site 6A plus 4 Wells at Site 10B, 4 Times, VOCs, SVOCs, PAHs, Water Quality Parameters
Annual Groundwater Sampling		$3,630			8 Wells at Site 6A plus 4 Wells at Site 10B, Labor
Annual Groundwater Analysis		$11,052			8 Wells at Site 6A plus 4 Wells at Site 10B, VOCs, SVOCs, PAHs, Water Quality Parameters
Annual Groundwater Sampling			$2,540		8 Wells at Site 6A, Labor
Annual Groundwater Analysis			$7,368		8 Wells at Site 6A, VOCs, SVOCs, PAHs, Water Quality Parameters
Annual Report	$10,000	$10,000	$10,000		
Inspection	$1,000	$1,000	$1,000		Annual LUC inspection (assume 8 hours at $50/hr plus expenses)
Site Review				$23,000	5-year review
TOTALS	$69,728	$25,682	$20,908	$23,000	

SITE 6A - FUEL CALIBRATION AREA, SITE 10B - ENGINE TEST HOUSE, AND ONSITE SOUTHERN AREA
NWIRP CALVERTON
CALVERTON, NEW YORK
ALT SAGW2: LAND USE CONTROLS / DEED NOTIFICATIONS, NATURAL ATTENTUATION, AND MONITORING
PRESENT WORTH ANALYSIS

Year	Capital Cost	Annual Cost	Total Year Cost	Annual Discount Rate at 7%	Present Worth
0	$180,503		$180,503	1.000	$180,503
1		$69,728	$69,728	0.935	$65,196
2		$25,682	$25,682	0.873	$22,420
3		$25,682	$25,682	0.816	$20,957
4		$25,682	$25,682	0.763	$19,595
5		$48,682	$48,682	0.713	$34,710
6		$25,682	$25,682	0.666	$17,104
7		$25,682	$25,682	0.623	$16,000
8		$25,682	$25,682	0.582	$14,947
9		$25,682	$25,682	0.544	$13,971
10		$48,682	$48,682	0.508	$24,730
11		$20,908	$20,908	0.475	$9,931
12		$20,908	$20,908	0.444	$9,283
13		$20,908	$20,908	0.415	$8,677
14		$20,908	$20,908	0.388	$8,112
15		$43,908	$43,908	0.362	$15,895
16		$20,908	$20,908	0.339	$7,088
17		$20,908	$20,908	0.317	$6,628
18		$20,908	$20,908	0.296	$6,189
19		$20,908	$20,908	0.277	$5,792
20		$43,908	$43,908	0.258	$11,328
21		$20,908	$20,908	0.242	$5,060
22		$20,908	$20,908	0.226	$4,725
23		$20,908	$20,908	0.211	$4,412
24		$20,908	$20,908	0.197	$4,119
25		$43,908	$43,908	0.184	$8,079
26		$20,908	$20,908	0.172	$3,596
27		$20,908	$20,908	0.161	$3,366
28		$20,908	$20,908	0.150	$3,136
29		$20,908	$20,908	0.141	$2,948
30		$43,908	$43,908	0.131	$5,752

TOTAL PRESENT WORTH $564,249

D.8 - ALTERNATIVE SAGW3
LAND USE CONTROLS/DEED NOTIFICATIONS,
GROUNDWATER EXTRACTION (WELLS),
TREATMENT (AIR STRIPPING/ACTIVATED CARBON),
RE-INJECTION (INFILTRATION GALLERIES), AND MONITORING

SITE 6A - FUEL CALIBRATION AREA, SITE 10B - ENGINE TEST HOUSE, AND ONSITE SOUTHERN AREA
NWIRP CALVERTON
CALVERTON, NEW YORK
ALT SAGW3: LAND USE CONTROLS / DEED NOTIFICATIONS, GROUNDWATER EXTRACTION (WELLS), TREATMENT (AIR STRIPPING / ACTIVATED CARBON), RE-INJECTION (INFILTRATION GALLERIES), AND MONITORING
CAPITAL COST

Item	Quantity	Unit	Unit Cost				Extended Cost				Subtotal
			Subcontract	Material	Labor	Equipment	Subcontract	Material	Labor	Equipment	
1 PROJECT PLANNING AND MOBILIZATION/DEMOBILIZATION											
1.1 Prepare Documents & Plans including Permits	300	hr			$52.50		$0	$0	$15,750	$0	$15,750
1.2 Land Use Controls / Deed Notifications	150	hr			$52.50		$0	$0	$7,875	$0	$7,875
2 MOBILIZATION/DEMOBILIZATION AND FIELD SUPPORT											
2.1 Office Trailer	4	mo				$202.50	$0	$0	$0	$810	$810
2.2 Office Trailer Mob/Demo	1	ea				$225.00	$0	$0	$0	$225	$225
2.3 Field Office Support	4	mo		$143.00			$0	$572	$0	$0	$572
2.4 Electrical Hook-up / Power Source	1	ls	$20,000.00				$20,000	$0	$0	$0	$20,000
2.5 Site Utilities (Phone & Electric)	4	mo		$302.00			$0	$1,208	$0	$0	$1,208
2.6 Drill Rig Mobilization/Demobilization	1	ls	$3,000.00				$3,000	$0	$0	$0	$3,000
2.7 Mobilization/Demobilization Construction Equipment	1	ea			$110.00	$224.00	$0	$0	$110	$224	$334
3 DECONTAMINATION											
3.1 Temporary Decon Pad	1	ls		$500.00	$450.00	$155.00	$0	$500	$450	$155	$1,105
3.2 Decontamination Services	3	mo		$210.00	$1,800.00	$315.00	$0	$630	$5,400	$945	$6,975
3.3 Decon Water	3,000	gal		$0.20			$0	$600	$0	$0	$600
3.4 Decon Water Storage Tank, 6,000 gallon	3	mo				$645.00	$0	$0	$0	$1,935	$1,935
3.5 Clean Water Storage Tank, 4,000 gallon	3	mo				$580.00	$0	$0	$0	$1,740	$1,740
3.6 Disposal of Decon Waste (Liquid & Solid)	3	mo	$900.00				$2,700	$0	$0	$0	$2,700
4 SITE 6A WELL INSTALLATION											
4.1 Extraction Wells (4 wells, 6" dia. @ 60' deep)	240	lf	$100.00				$24,000	$0	$0	$0	$24,000
4.2 Submersible Centrifugal Pumps (20 gpm, 100 ft head, 0.5 HP)	4	ea		$1,974.00	$510.90	$143.75	$0	$7,896	$2,044	$575	$10,515
4.3 Excavate/Backfill Pipe 4' Deep Trench	500	lf			$2.74	$0.79	$0	$0	$1,370	$395	$1,765
4.4 4-inch Dia. PVC Piping	500	ft		$5.99	$5.75	$9.45	$0	$2,997	$2,875	$4,725	$10,597
5 SITE 6A ON-SITE TREATMENT SYSTEM											
5.1 Building Foundation	1,000	sf	$4.06				$4,060	$0	$0	$0	$4,060
5.2 Treatment Building	1,000	sf	$11.58				$11,580	$0	$0	$0	$11,580
5.3 Building Misc. (doors/vent/insulation/misc.)	1	ls	$6,012.00				$6,012	$0	$0	$0	$6,012
5.5 Oil-Water Separator, 1000 Gallons	1	ea		$12,700.00			$0	$12,700	$0	$0	$12,700
5.6 7.5 Ft Dia Equalization Tank (2,500 gal)	1	ea		$3,800.00	$272.00		$0	$3,800	$272	$0	$4,072
5.7 Top Mounted Low-Speed Turbine-Type Mixer (1.25 hp)	1	ea		$2,618.00	$51.56		$0	$2,618	$52	$0	$2,670
5.8 Horizontal-Centrifugal Pump, 80 gpm, 5 HP, 100 ft head	2	ea		$964.65	$400.78		$0	$1,929	$802	$0	$2,731
5.8 16 Ft Diameter, 13,000 Gallon Clarifier Tank	1	ea		$78,500.00	$26,066.00	$8,570.00	$0	$78,500	$26,066	$8,570	$113,136
5.9 Bag Filter, Multi-Bag, 60 sf total	2	ea		$806.45			$0	$1,613	$0	$0	$1,613
5.10 Air Stripper, 80 gpm, 600 cfm Blower & Control Panel	1	ea		$19,000.00			$0	$19,000	$0	$0	$19,000
5.11 Excavate/Backfill Pipe 4' Deep Trench to Infilration Beds	200	lf			$2.74	$0.79	$0	$0	$548	$158	$706
5.12 2-inch Dia. PVC Piping to Infiltration Beds	200	ft		$1.72	$3.93	$6.45	$0	$343	$786	$1,290	$2,419
5.13 Excavate/Backfill Pipe 4' Deep Trench / Infiltration Beds	800	lf			$2.74	$0.79	$0	$0	$2,192	$632	$2,824
5.14 Geotextile for Infiltration Beds	268	sy		$1.28	$0.18		$0	$343	$48	$0	$391
5.15 Gravel Layer, 8 Beds, Each 100 Ft Long, 6 Inches x 1 Ft	16	cy		$27.50	$2.47	$4.22	$0	$440	$40	$68	$547
5.16 2-inch Dia. PVC Piping, Perforated	1	ft		$2.57	$3.93	$6.45	$0	$3	$4	$6	$13
5.17 Caustic Feed System	1	ea		$8,655.00	$2,165.00		$0	$8,655	$2,165	$0	$10,820
5.18 Potassium Permanganate Feed System	1	ea		$1,085.00	$2,165.00		$0	$1,085	$2,165	$0	$3,250
5.19 Plumb/Electrify System	1	ls		$4,500.00	$3,264.00		$0	$4,500	$3,264	$0	$7,764
5.20 System Start-Up and Testing	1	ls		$1,000.00	$1,750.00		$0	$1,000	$1,750	$0	$2,750
6 SITE 10B WELL INSTALLATION											
6.1 Extraction Wells (2 wells, 6" dia. @ 60' deep)	120	lf	$100.00				$12,000	$0	$0	$0	$12,000
6.2 Submersible Centrifugal Pumps (20 gpm, 100 ft head, 0.5 HP)	2	ea		$1,974.00	$510.90	$143.75	$0	$3,948	$1,022	$288	$5,257
6.3 Excavate/Backfill Pipe 4' Deep Trench	500	lf			$2.74	$0.79	$0	$0	$1,370	$395	$1,765
6.4 2-inch Dia. PVC Piping	500	ft		$1.72	$3.93	$6.45	$0	$858	$1,965	$3,225	$6,048
7 SITE 10B ON-SITE TREATMENT SYSTEM											
7.1 Building Foundation	1,000	sf	$4.06				$4,060	$0	$0	$0	$4,060

SITE 6A - FUEL CALIBRATION AREA, SITE 10B - ENGINE TEST HOUSE, AND ONSITE SOUTHERN AREA
NWIRP CALVERTON
CALVERTON, NEW YORK
ALT SAGW3: LAND USE CONTROLS / DEED NOTIFICATIONS, GROUNDWATER EXTRACTION (WELLS), TREATMENT (AIR STRIPPING / ACTIVATED CARBON), RE-INJECTION (INFILTRATION GALLERIES), AND MONITORING
CAPITAL COST

Item	Quantity	Unit	Unit Cost				Extended Cost				Subtotal
			Subcontract	Material	Labor	Equipment	Subcontract	Material	Labor	Equipment	
7.2 Treatment Building	1,000	sf	$11.58				$11,580	$0	$0	$0	$11,580
7.3 Building Misc. (doors/vent/insulation/misc.)	1	ls	$6,012.00				$6,012	$0	$0	$0	$6,012
7.4 6 Ft Dia Equalization Tank (1250 gal))	1	ea		$2,968.90	$666.60	$15.40	$0	$2,969	$667	$15	$3,651
7.5 Top Mounted Low-Speed Turbine-Type Mixer (0.6 hp)	1	ea		$1,988.00	$51.56		$0	$1,988	$52	$0	$2,040
7.6 Horizontal-Centrifugal Pump, 40 gpm, 3 HP, 100 ft head	2	ea		$570.96	$331.06		$0	$1,142	$662	$0	$1,804
7.7 12 Ft Diameter, 5,000 Gallon Clarifier Tank	1	ea		$69,000.00	$21,722.00	$7,142.00	$0	$69,000	$21,722	$7,142	$97,864
7.8 Bag Filter, Multi-Bag, 30 sf total	2	ea		$588.82			$0	$1,178	$0	$0	$1,178
7.9 Air Stripper, 40 gpm, 300 cfm Blower & Control Panel	1	ea		$19,000.00			$0	$19,000	$0	$0	$19,000
7.10 Excavate/Backfill Pipe 4' Deep Trench to Infilration Beds	200	lf			$2.74	$0.79	$0	$0	$548	$158	$706
7.11 2-inch Dia. PVC Piping to Infiltration Beds	200	ft		$1.72	$3.93	$6.45	$0	$343	$786	$1,290	$2,419
7.12 Excavate/Backfill Pipe 4' Deep Trench / Infiltration Beds	400	lf			$2.74	$0.79	$0	$0	$1,096	$316	$1,412
7.13 Geotextile for Infiltration Beds	132	sy		$1.28	$0.18		$0	$169	$24	$0	$193
7.14 Gravel Layer, 4 Beds, Each 100 Ft Long, 6 Inches x 1 Ft	8	cy		$27.50	$2.47	$4.22	$0	$220	$20	$34	$274
7.15 2-inch Dia. PVC Piping, Perforated	400	ft		$2.57	$3.93	$6.45	$0	$1,030	$1,572	$2,580	$5,182
7.16 Caustic Feed System	1	ea		$8,655.00	$2,165.00		$0	$8,655	$2,165	$0	$10,820
7.17 Potassium Permanganate Feed System	1	ea		$1,085.00	$2,165.00		$0	$1,085	$2,165	$0	$3,250
7.18 Plumb/Electrify System	1	ls		$3,000.00	$1,958.40		$0	$3,000	$1,958	$0	$4,958
7.19 System Start-Up and Testing	1	ls		$1,000.00	$1,750.00		$0	$1,000	$1,750	$0	$2,750
8 **MISCELLANEOUS**											
8.1 Construction Oversite (2p * 4 months)	168	mn-days			$240.00		$0	$0	$40,320	$0	$40,320
8.2 Post Construction Documents	125	hr			$52.50		$0	$0	$6,563	$0	$6,563
8.3 Vegetate Disturbed Areas	1	ls		$600.00	$1,000.00	$400.00	$0	$600	$1,000	$400	$2,000
Subtotal							105004	$267,116	$163,452	$38,296	$573,867
Local Area Adjustments							100.0%	112.3%	130.4%	130.4%	
							$105,004	$299,971	$213,141	$49,938	$668,054
Overhead on Labor Cost @ 30%									$63,942		$63,942
G & A on Labor Cost @ 10%									$21,314		$21,314
G & A on Material Cost @ 10%								$29,997			$29,997
G & A on Equipment Cost @ 10%										$4,994	$4,994
G & A on Subcontract Cost @ 10%							$10,500				$10,500
Total Direct Cost							$115,504	$329,968	$298,398	$54,931	$798,802
Indirects on Total Direct Cost @ 35%			(Total Direct Cost Minus Transportation and Disposal Costs)								$278,636
Profit on Total Direct Cost @ 10%											$79,880
Subtotal											$1,157,317
Health & Safety Monitoring @ 2%											$23,146
Total Field Cost											$1,180,464
Contingency on Subtotal Cost @ 25%											$295,116
Engineering on Subtotal Cost @ 15%											$177,070
TOTAL COST											**$1,652,649**

SITE 6A - FUEL CALIBRATION AREA, SITE 10B - ENGINE TEST HOUSE, AND ONSITE SOUTHERN AREA
NWIRP CALVERTON
CALVERTON, NEW YORK
ALT SAGW3: LAND USE CONTROLS / DEED NOTIFICATIONS, GROUNDWATER EXTRACTION (WELLS), TREATMENT (AIR STRIPPING / ACTIVATED CARBON), RE-INJECTION (INFILTRATION GALLERIES), AND MONITORING
OPERATION AND MAINTENANCE COSTS PER YEAR

	Item	Qty	Unit	Unit Cost	Subtotal Cost	Notes
	Site 6A - Year 1					
1	Energy - Electric	66,956	kWh	$0.12	$8,035	
2	Maintenance	1	ls	$9,370.32	$9,370	5% of Installation Cost
3	Labor, Per Diem, Supplies	52	day	$350.00	$18,200	1 visit per week - 1 day
4	Caustic Soda	8	ton	$435.00	$3,480	
5	Potassium Permanganate	3600	lb	$1.65	$5,940	
6	Influent (Four Wells) and Effluent Sampling	75	ea	$617.50	$46,313	Weekly for first month, then once a month each for VOCs, SVOCs, and PAHs, + 30% for quality assurance
7	Semi-Annual Reports	4	ea	$4,000.00	$16,000	
	Subtotal Cost for One Year Operation				$107,338	
	Site 10B - Year 1					
1	Energy - Electric	36,581	kWh	$0.12	$4,390	
2	Maintenance	1	ls	$7,752.42	$7,752	5% of Installation Cost
3	Labor, Per Diem, Supplies	52	day	$350.00	$18,200	1 visit per week - 1 day
4	Caustic Soda	4	ton	$435.00	$1,740	
5	Potassium Permanganate	1800	lb	$1.65	$2,970	
6	Influent (Two Wells) and Effluent Sampling	30	ea	$617.50	$18,525	Weekly for first month, then once a month each for VOCs, SVOCs, and PAHs, + 30% for quality assurance
7	Semi-Annual Reports	4	ea	$4,000.00	$16,000	
	Subtotal Cost for One Year Operation				$69,577	
	Site 6A - Years 2 through 30					
1	Energy - Electric	66,956	kWh	$0.12	$8,035	
2	Maintenance	1	ls	$9,370.32	$9,370	5% of Installation Cost
3	Labor, Per Diem, Supplies	52	day	$350.00	$18,200	1 visit per week - 1 day
4	Caustic Soda	8	ton	$435.00	$3,480	
5	Potassium Permanganate	3600	lb	$1.65	$5,940	
6	Influent (Four Wells) and Effluent Sampling	60	ea	$617.50	$37,050	Once/month each for VOCs, SVOCs, and PAHs, + 30% for QA
7	Semi-Annual Reports	4	ea	$4,000.00	$16,000	
	Subtotal Cost for One Year Operation				$98,075	
	Site 10B - Years 2 through 9					
1	Energy - Electric	36,581	kWh	$0.12	$4,390	
2	Maintenance	1	ls	$7,752.42	$7,752	5% of Installation Cost
3	Labor, Per Diem, Supplies	52	day	$350.00	$18,200	1 visit per week - 1 day
4	Caustic Soda	4	ton	$435.00	$1,740	
5	Potassium Permanganate	1800	lb	$1.65	$2,970	
6	Influent (Two Wells) and Effluent Sampling	24	ea	$617.50	$14,820	Once/month each for VOCs, SVOCs, and PAHs, + 30% for QA
7	Semi-Annual Reports	4	ea	$4,000.00	$16,000	
	Subtotal Cost for One Year Operation				$65,872	

SITE 6A - FUEL CALIBRATION AREA, SITE 10B - ENGINE TEST HOUSE, AND ONSITE SOUTHERN AREA
NWIRP CALVERTON
CALVERTON, NEW YORK
ALT SAGW3: LAND USE CONTROLS / DEED NOTIFICATIONS, GROUNDWATER EXTRACTION (WELLS), TREATMENT (AIR STRIPPING / ACTIVATED CARBON); RE-INJECTION (INFILTRATION GALLERIES), AND MONITORING
ANNUAL COST

Item	Item Cost Year 1	Item Cost Years 2 through 9	Item Cost Years 10 through	Item Cost Every 5 Years	Notes
Quarterly Groundwater Sampling	$14,520				8 Wells at Site 6A plus 4 Wells at Site 10B, 4 times, Labor
Quarterly Groundwater Analysis	$44,208				8 Wells at Site 6A plus 4 Wells at Site 10B, 4 Times, VOCs, SVOCs, PAHs, Water Quality Parameters
Annual Groundwater Sampling		$3,630			8 Wells at Site 6A plus 4 Wells at Site 10B, Labor
Annual Groundwater Analysis		$11,052			8 Wells at Site 6A plus 4 Wells at Site 10B, VOCs, SVOCs, PAHs, Water Quality Parameters
Annual Groundwater Sampling			$2,540		8 Wells at Site 6A, Labor
Annual Groundwater Analysis			$7,368		8 Wells at Site 6A, VOCs, SVOCs, PAHs, Water Quality Parameters
Annual Report	$10,000	$10,000	$10,000		
Inspection	$1,000	$1,000	$1,000		Annual LUC inspection (assume 8 hours at $50/hr plus expenses)
Site Review				$23,000	5-year review
TOTALS	$69,728	$25,682	$20,908	$23,000	

SITE 6A - FUEL CALIBRATION AREA, SITE 10B - ENGINE TEST HOUSE, AND ONSITE SOUTHERN AREA
NWIRP CALVERTON
CALVERTON, NEW YORK
ALT SAGW3: LAND USE CONTROLS / DEED NOTIFICATIONS, GROUNDWATER EXTRACTION (WELLS), TREATMENT (AIR STRIPPING / ACTIVATED CARBON), RE-INJECTION (INFILTRATION GALLERIES), AND MONITORING
PRESENT WORTH ANALYSIS

Year	Capital Cost	Operation and Maintenance Cost	Annual Cost	Total Year Cost	Annual Discount Rate at 7%	Present Worth
0	$1,652,649			$1,652,649	1.000	$1,652,649
1		$176,915	$69,728	$246,643	0.935	$230,611
2		$163,947	$25,682	$189,629	0.873	$165,546
3		$163,947	$25,682	$189,629	0.816	$154,737
4		$163,947	$25,682	$189,629	0.763	$144,687
5		$163,947	$48,682	$212,629	0.713	$151,605
6		$163,947	$25,682	$189,629	0.666	$126,293
7		$163,947	$25,682	$189,629	0.623	$118,139
8		$163,947	$25,682	$189,629	0.582	$110,364
9		$163,947	$25,682	$189,629	0.544	$103,158
10		$98,075	$43,908	$141,983	0.508	$72,127
11		$98,075	$20,908	$118,983	0.475	$56,517
12		$98,075	$20,908	$118,983	0.444	$52,828
13		$98,075	$20,908	$118,983	0.415	$49,378
14		$98,075	$20,908	$118,983	0.388	$46,165
15		$98,075	$43,908	$141,983	0.362	$51,398
16		$98,075	$20,908	$118,983	0.339	$40,335
17		$98,075	$20,908	$118,983	0.317	$37,718
18		$98,075	$20,908	$118,983	0.296	$35,219
19		$98,075	$20,908	$118,983	0.277	$32,958
20		$98,075	$43,908	$141,983	0.258	$36,632
21		$98,075	$20,908	$118,983	0.242	$28,794
22		$98,075	$20,908	$118,983	0.226	$26,890
23		$98,075	$20,908	$118,983	0.211	$25,105
24		$98,075	$20,908	$118,983	0.197	$23,440
25		$98,075	$43,908	$141,983	0.184	$26,125
26		$98,075	$20,908	$118,983	0.172	$20,465
27		$98,075	$20,908	$118,983	0.161	$19,156
28		$98,075	$20,908	$118,983	0.150	$17,847
29		$98,075	$20,908	$118,983	0.141	$16,777
30		$98,075	$43,908	$141,983	0.131	$18,600
					TOTAL PRESENT WORTH	**$3,692,265**

D.9 - ALTERNATIVE SAGW4

LAND USE CONTROLS/DEED NOTIFICATIONS, IN-SITU TREATMENT (AIR SPARGING), AND MONITORING

SITE 6A - FUEL CALIBRATION AREA, SITE 10B - ENGINE TEST HOUSE, AND ONSITE SOUTHERN AREA
NWIRP CALVERTON
CALVERTON, NEW YORK
ALT SAGW4: LAND USE CONTROLS / DEED NOTIFICATIONS, IN-SITU TREATMENT (AIR SPARGING), AND MONITORING
CAPITAL COST

Item	Quantity	Unit	Unit Cost				Extended Cost				Subtotal
			Subcontract	Material	Labor	Equipment	Subcontract	Material	Labor	Equipment	
1 PROJECT PLANNING											
1.1 Prepare Remedial Action Plan	300	hr			$52.50		$0	$0	$15,750	$0	$15,750
1.2 Land Use Controls / Deed Notifications	150	hr			$52.50		$0	$0	$7,875	$0	$7,875
2 MOBILIZATION/DEMOBILIZATION AND FIELD SUPPORT											
2.1 Office Trailer	5	mo		$203.50			$0	$1,018	$0	$0	$1,018
2.2 Storage Trailer	5	mo		$105.00			$0	$525	$0	$0	$525
2.3 Construction Survey	1	ls	$1,000.00				$1,000	$0	$0	$0	$1,000
2.4 Equipment Mobilization/Demobilization, Less than 150 HP	2	ea			$55.00	$112.00	$0	$0	$110	$224	$334
2.5 Drill Rig Mobilization/Demobilization	1	ls			$1,000.00	$4,000.00	$0	$0	$1,000	$4,000	$5,000
2.6 Site Utilities	5	mo	$200.00				$1,000	$0	$0	$0	$1,000
2.7 Electrical Hook-up / Power Source	1	ls	$5,000.00				$5,000	$0	$0	$0	$5,000
3 DECONTAMINATION											
3.1 Temporary Decon Pad	1	ls		$500.00	$450.00	$155.00	$0	$500	$450	$155	$1,105
3.2 Decontamination Services	4	mo		$210.00	$1,800.00	$315.00	$0	$840	$7,200	$1,260	$9,300
3.3 Decon Water	4,000	gal		$0.20			$0	$800	$0	$0	$800
3.4 Decon Water Storage Tank, 6,000 gallon	4	mo				$635.00	$0	$0	$0	$2,540	$2,540
3.5 Clean Water Storage Tank, 4,000 gallon	4	mo				$570.00	$0	$0	$0	$2,280	$2,280
3.6 Disposal of Decon Waste (Liquid & Solid)	4	mo	$900.00				$3,600	$0	$0	$0	$3,600
4 SITE 6A MONITORING WELL INSTALLATION											
4.1 Install Monitoring Wells, 2 wells, 30 ft each	60	ft	$35.00				$2,100	$0	$0	$0	$2,100
4.2 Flushmounts	2	ea	$120.00				$240	$0	$0	$0	$240
4.3 Collect/Containerize IDW	2	ea	$50.00				$100	$0	$0	$0	$100
4.4 Transport/Dispose IDW Off Site	2	drums	$150.00				$300	$0	$0	$0	$300
5 SITE 6A AIR SPARGING WELL INSTALLATION											
5.1 Install Site 6A Air Sparging Wells, 51 wells, 30 ft each	1,530	ft	$32.00				$48,960	$0	$0	$0	$48,960
5.2 2-inch Dia. PVC Piping	3,000	ft		$1.72	$3.93	$6.45	$0	$5,148	$11,790	$19,350	$36,288
5.3 6" DeepTrench	3,000	ft			$0.44	$0.14	$0	$0	$1,305	$405	$1,710
5.4 Piping, Tees, 2"	51	ea		$29.25	$21.50		$0	$1,492	$1,097	$0	$2,588
5.5 Roll Off Box for IDW- Mob/Demob/Disposal	2	ea	$2,460.00				$4,920	$0	$0	$0	$4,920
5.6 Frac Tank for IDW Water	1	mo	$2,000.00				$2,000	$0	$0	$0	$2,000
5.7 Transport/Dispose IDW Water	10,200	gal	$0.05				$510	$0	$0	$0	$510
6 SITE 6A AS SYSTEM INSTALLATION											
6.1 Pilot Scale Testing	1	ls	$15,000.00				$15,000	$0	$0	$0	$15,000
6.2 Skid-Mounted 600 cfm Blower with Controls @ 17 psi	1	ea		$13,000.00			$0	$13,000	$0	$0	$13,000
6.3 Pressure Gages	6	ea		$70.00			$0	$420	$0	$0	$420
6.4 Electrician, Miscellaneous Electrical	1	ls		$5,000.00	$1,630.00		$0	$5,000	$1,630	$0	$6,630
6.5 Telemetry System	1	ls	$3,000.00				$3,000	$0	$0	$0	$3,000
6.6 Systems Start-up and Testing, 2 People for 2 Weeks	4	mn-wks			$1,500.00		$0	$0	$6,000	$0	$6,000
7 SITE 10B MONITORING WELL INSTALLATION											
7.1 Install Monitoring Wells, 4 wells, 30 ft each	120	ft	$35.00				$4,200	$0	$0	$0	$4,200
7.2 Flushmounts	4	ea	$120.00				$480	$0	$0	$0	$480
7.3 Collect/Containerize IDW	4	ea	$50.00				$200	$0	$0	$0	$200
7.4 Transport/Dispose IDW Off Site	4	drums	$150.00				$600	$0	$0	$0	$600
8 SITE 10B AIR SPARGING WELL INSTALLATION											
8.1 Install Site 10B Air Sparging Wells, 13 wells, 30 ft each	390	ft	$35.00				$13,650	$0	$0	$0	$13,650
8.2 2-inch Dia. PVC Piping	900	ft		$1.72	$3.93	$6.45	$0	$1,544	$3,537	$5,805	$10,886
8.3 6" DeepTrench	900	ft			$0.44	$0.14	$0	$0	$392	$122	$513
8.4 Piping, Tees, 2"	13	ea		$29.25	$21.50		$0	$380	$280	$0	$660
8.5 Collect/Containerize IDW	9	ea	$50.00				$450	$0	$0	$0	$450
8.6 Transport/Dispose IDW Off Site	9	drums	$150.00				$1,350	$0	$0	$0	$1,350
9 SITE 10B AS SYSTEM INSTALLATION											
9.1 Pilot Scale Testing	1	ls	$15,000.00				$15,000	$0	$0	$0	$15,000
9.2 Skid-Mounted 160 cfm Blower with Controls @ 17 psi	1	ea		$7,000.00			$0	$7,000	$0	$0	$7,000
9.3 Pressure Gages	4	ea		$70.00			$0	$280	$0	$0	$280

SITE 6A - FUEL CALIBRATION AREA, SITE 10B - ENGINE TEST HOUSE, AND ONSITE SOUTHERN AREA
NWIRP CALVERTON
CALVERTON, NEW YORK
ALT SAGW4: LAND USE CONTROLS / DEED NOTIFICATIONS, IN-SITU TREATMENT (AIR SPARGING), AND MONITORING
CAPITAL COST

Item	Quantity	Unit	Unit Cost				Extended Cost				Subtotal
			Subcontract	Material	Labor	Equipment	Subcontract	Material	Labor	Equipment	
9.4 Electrician, Miscellaneous Electrical	1	ls		$5,000.00	$1,630.00		$0	$5,000	$1,630	$0	$6,630
9.5 Telemetry System	1	ls	$3,000.00				$3,000	$0	$0	$0	$3,000
9.6 Systems Start-up and Testing, 2 People for 1 Week	2	mn-wks			$1,500.00		$0	$0	$3,000	$0	$3,000
10 MISCELLANEOUS											
10.1 Prepare Post-Construction Documents	100	hours			$35.00		$0	$0	$3,500	$0	$3,500
10.2 Construction Oversight (2p * 5days * 18 weeks)	180	mn-days			$160.00		$0	$0	$28,800	$0	$28,800
11 SITE RESTORATION											
11.1 Repair asphalt	1	ls		$2,500.00	$25,000.00	$1,000.00	$0	$2,500	$25,000	$1,000	$28,500
Subtotal Direct Costs less Subcontract							$126,660	$45,447	$120,345	$37,141	$329,592
Local Area Adjustments							100.0%	112.3%	130.4%	130.4%	
							$126,660	$51,037	$156,929	$48,431	$383,057
Overhead on Labor Cost @ 30%									$47,079		$47,079
G & A on Labor Cost @ 10%									$15,693		$15,693
G & A on Material Cost @ 10%								$5,104			$5,104
G & A on Equipment Cost @ 10%										$4,843	$4,843
G & A on Subcontract Cost @ 10%							$12,666				$12,666
Total Direct Cost							$139,326	$56,141	$219,701	$53,274	$468,442
Indirects on Total Direct Cost @ 35%			(Total Direct Cost Minus Transportation and Disposal Costs)								$161,729
Profit on Total Direct Cost @ 10%											$46,844
Subtotal											$677,015
Health & Safety Monitoring @ 2%											$13,540
Total Field Cost											$690,555
Contingency on Total Field Costs @ 25%											$172,639
Engineering on Total Field Cost @ 15%											$103,583
TOTAL COST											**$966,777**

SITE 6A - FUEL CALIBRATION AREA, SITE 10B - ENGINE TEST HOUSE, AND ONSITE SOUTHERN AREA
NWIRP CALVERTON
CALVERTON, NEW YORK
ALT SAGW4: LAND USE CONTROLS / DEED NOTIFICATIONS, IN-SITU TREATMENT (AIR SPARGING), AND MONITORING
OPERATION AND MAINTENANCE COSTS PER YEAR

	Item	Qty	Unit	Unit Cost	Subtotal Cost	Notes
	Site 6A					
1	Energy - Electric	261,293	kWh	$0.12	$31,355	
2	Maintenance	1	ls	$7,051.31	$7,051	5% of Installation Cost
3	Labor	52	wk	$320.00	$16,640	1 visit per week - 1/2 day
4	Quarterly Reports	4	ea	$4,000.00	$16,000	
	Subtotal Cost per Year of Operation				$71,047	
	Site 10B					
1	Energy - Electric	97,985	kWh	$0.12	$11,758	
2	Maintenance	1	ls	$3,120.96	$3,121	5% of Installation Cost
3	Labor	52	wk	$320.00	$16,640	1 visit per week - 1/2 day
4	Quarterly Reports	4	ea	$4,000.00	$16,000	
	Subtotal Cost per Year of Operation				$47,519	

SITE 6A - FUEL CALIBRATION AREA, SITE 10B - ENGINE TEST HOUSE, AND ONSITE SOUTHERN AREA
NWIRP CALVERTON
CALVERTON, NEW YORK
ALT SAGW4: LAND USE CONTROLS / DEED NOTIFICATIONS, IN-SITU TREATMENT (AIR SPARGING), AND MONITORING
ANNUAL COST

Item	Item Cost Year 1	Item Cost Years 2 through 4	Notes
Quarterly Groundwater Sampling	$14,520		8 Wells at Site 6A plus 4 Wells at Site 10B, 4 times, Labor
Quarterly Groundwater Analysis	$44,208		8 Wells at Site 6A plus 4 Wells at Site 10B, 4 Times, VOCs, SVOCs, PAHs, Water Quality Parameters
Annual Groundwater Sampling		$3,630	8 Wells at Site 6A plus 4 Wells at Site 10B, Labor
Annual Groundwater Analysis		$11,052	8 Wells at Site 6A plus 4 Wells at Site 10B, VOCs, SVOCs, PAHs, Water Quality Parameters
Annual Groundwater Sampling			8 Wells at Site 6A, Labor
Annual Groundwater Analysis			8 Wells at Site 6A, VOCs, SVOCs, PAHs, Water Quality Parameters
Annual Report	$10,000	$10,000	
Inspection	$1,000	$1,000	Annual LUC inspection (assume 8 hours at $50/hr plus expenses)
TOTALS	$69,728	$25,682	

SITE 6A - FUEL CALIBRATION AREA, SITE 10B - ENGINE TEST HOUSE, AND ONSITE SOUTHERN AREA
NWIRP CALVERTON
CALVERTON, NEW YORK
ALT SAGW4: LAND USE CONTROLS / DEED NOTIFICATIONS, IN-SITU TREATMENT (AIR SPARGING), AND MONITORING
PRESENT WORTH ANALYSIS

Year	Capital Cost	Operation & Maintenance Cost	Annual Cost	Total Year Cost	Annual Discount Rate at 7%	Present Worth
0	$966,777			$966,777	1.000	$966,777
1		$118,566	$69,728	$188,294	0.935	$176,055
2		$118,566	$25,682	$144,248	0.873	$125,928
3		$118,566	$25,682	$144,248	0.816	$117,706
4		$118,566	$25,682	$144,248	0.763	$110,061

TOTAL PRESENT WORTH $1,496,527

D.10 - ALTERNATIVE SAGW5

LAND USE CONTROLS/ DEED NOTIFICATIONS, IN-SITU BIOLOGICAL TREATMENT (BIOSTIMULATION WITH HRC AND ORC), NATURAL ATTENUATION, AND MONITORING

SITE 6A - FUEL CALIBRATION AREA, SITE 10B - ENGINE TEST HOUSE, AND ONSITE SOUTHERN AREA
NWIRP CALVERTON
CALVERTON, NEW YORK
ALT SAGW5: LAND USE CONTROLS / DEED NOTIFICATIONS, IN-SITU BIOLOGICAL TREATMENT (BIOSTIMULATION WITH HRC AND ORC), NATURAL ATTENTUATION, AND MONITORING
CAPITAL COST

Item	Quantity	Unit	Unit Cost				Extended Cost				Subtotal
			Subcontract	Material	Labor	Equipment	Subcontract	Material	Labor	Equipment	
1 PROJECT PLANNING											
1.1 Prepare Remedial Action Plan	100	hr			$52.50		$0	$0	$5,250	$0	$5,250
1.2 Land Use Controls / Deed Notifications	150	hr			$52.50		$0	$0	$7,875	$0	$7,875
1.3 Pilot Study	1	ls	$2,000.00	$98,000.00			$2,000	$98,000	$0	$0	$100,000
2 MOBILIZATION/DEMOBILIZATION AND FIELD SUPPORT											
2.1 Office Trailer	4	mo		$202.50			$0	$810	$0	$0	$810
2.2 Storage Trailer	4	mo		$105.00			$0	$420	$0	$0	$420
2.3 Construction Survey	2	ac	$1,200.00				$2,400	$0	$0	$0	$2,400
2.4 DPT Rig Mobilization/Demobilization	2	ea	$3,000.00				$6,000	$0	$0	$0	$6,000
2.5 Site Utilities	3	mo		$427.00			$0	$1,281	$0	$0	$1,281
3 DECONTAMINATION											
3.1 Temporary Decon Pad	1	ls		$500.00	$450.00	$155.00	$0	$500	$450	$155	$1,105
3.2 Decontamination Services	4	mo		$210.00	$1,800.00	$315.00	$0	$840	$7,200	$1,260	$9,300
3.3 Decon Water	4,000	gal		$0.20			$0	$800	$0	$0	$800
3.4 Decon Water Storage Tank, 6,000 gallon	4	mo				$645.00	$0	$0	$0	$2,580	$2,580
3.5 Clean Water Storage Tank, 4,000 gallon	4	mo				$580.00	$0	$0	$0	$2,320	$2,320
3.6 Disposal of Decon Waste (Liquid & Solid)	4	mo	$900.00				$3,600	$0	$0	$0	$3,600
4 SITE 6A MONITORING WELL INSTALLATION											
4.1 Install Monitoring Wells, 2 wells, 30 ft each	60	ft	$35.00				$2,100	$0	$0	$0	$2,100
4.2 Flushmounts	2	ea	$120.00				$240	$0	$0	$0	$240
4.3 Collect/Containerize IDW	2	ea	$50.00				$100	$0	$0	$0	$100
4.4 Transport/Dispose IDW Off Site	2	drums	$150.00				$300	$0	$0	$0	$300
5 SITE 10B MONITORING WELL INSTALLATION											
5.1 Install Monitoring Wells, 4 wells, 30 ft each	120	ft	$35.00				$4,200	$0	$0	$0	$4,200
5.2 Flushmounts	4	ea	$120.00				$480	$0	$0	$0	$480
5.3 Collect/Containerize IDW	4	ea	$50.00				$200	$0	$0	$0	$200
5.4 Transport/Dispose IDW Off Site	4	drums	$150.00				$600	$0	$0	$0	$600
6 BASELINE SAMPLING EVENT											
6.1 Sampling, Labor, Rental Car, and Supplies	1	ea		$900.00	$2,520.00	$210.00	$0	$900	$2,520	$210	$3,630
6.2 Sampling, Analytical for VOCs, SVOCs, PAHs, Water Quality	12	ea	$920.00				$11,040	$0	$0	$0	$11,040
7 HRC INJECTION - SITE 6A											
7.1 HRC Injection (126 points @ 40' deep)	15	day	$3,070.00				$46,050	$0	$0	$0	$46,050
7.2 HRC Material	32,430	lb		$5.86			$0	$190,040	$0	$0	$190,040
7.3 Waste/Soil Disposal	1	ls	$3,000.00				$3,000	$0	$0	$0	$3,000
8 HRC INJECTION - SITE 10B											
8.1 HRC Injection (30 points @ 30' deep)	2	day	$3,070.00				$6,140	$0	$0	$0	$6,140
8.2 HRC Material	5,700	lb		$5.86			$0	$33,402	$0	$0	$33,402
8.3 Waste/Soil Disposal	1	ls	$3,000.00				$3,000	$0	$0	$0	$3,000
9 ORC INJECTION - SITE 6A											
9.1 ORC Injection (234 points @ 40' deep)	25	day	$3,070.00				$76,750	$0	$0	$0	$76,750
9.2 ORC Material	21,000	lb		$8.56			$0	$179,760	$0	$0	$179,760
9.3 Waste/Soil Disposal	1	ls	$3,000.00				$3,000	$0	$0	$0	$3,000
10 ORC INJECTION - SITE 10B											
10.1 ORC Injection (120 points @ 30' deep)	12	day	$3,070.00				$36,840	$0	$0	$0	$36,840
10.2 ORC Material	7,200	lb		$8.56			$0	$61,632	$0	$0	$61,632
10.3 Waste/Soil Disposal	1	ls	$3,000.00				$3,000	$0	$0	$0	$3,000
11 MISCELLANEOUS											
11.1 Prepare Post-Construction Documents	150	hours			$52.50		$0	$0	$7,875	$0	$7,875
11.2 Construction Oversight (2p*4 months)	168	mn-days			$240.00		$0	$0	$40,320	$0	$40,320
Subtotal							$211,040	$568,385	$71,490	$6,525	$857,440
Local Area Adjustments							100.0%	112.3%	130.4%	130.4%	

SITE 6A - FUEL CALIBRATION AREA, SITE 10B - ENGINE TEST HOUSE, AND ONSITE SOUTHERN AREA
NWIRP CALVERTON
CALVERTON, NEW YORK
ALT SAGW5: LAND USE CONTROLS / DEED NOTIFICATIONS, IN-SITU BIOLOGICAL TREATMENT (BIOSTIMULATION WITH HRC AND ORC), NATURAL ATTENTUATION, AND MONITORING
CAPITAL COST

Item	Quantity	Unit	Unit Cost				Extended Cost				Subtotal
			Subcontract	Material	Labor	Equipment	Subcontract	Material	Labor	Equipment	
							$211,040	$638,296	$93,223	$8,509	$951,068
Overhead on Labor Cost @	30%								$27,967		$27,967
G & A on Labor Cost @	10%								$9,322		$9,322
G & A on Material Cost @	10%							$63,830			$63,830
G & A on Subcontract Cost @	10%						$21,104				$21,104
G & A on Equipment Cost @	10%									$851	$851
Total Direct Cost							$232,144	$702,126	$130,512	$9,359	$1,074,141
Indirects on Total Direct Cost @	25%		(Total Direct Cost Minus Transportation and Disposal Costs)								$264,410
Profit on Total Direct Cost @	10%										$107,414
Subtotal											$1,445,966
Health & Safety Monitoring @	1%										$14,460
Total Field Cost											$1,460,425
Contingency on Total Field Costs @	25%										$365,106
Engineering on Total Field Cost @	5%										$73,021
TOTAL COST											**$1,898,553**

SITE 6A - FUEL CALIBRATION AREA, SITE 10B - ENGINE TEST HOUSE, AND ONSITE SOUTHERN AREA
NWIRP CALVERTON
CALVERTON, NEW YORK
ALT SAGW5: LAND USE CONTROLS / DEED NOTIFICATIONS, IN-SITU BIOLOGICAL TREATMENT (BIOSTIMULATION WITH HRC AND ORC), NATURAL ATTENTUATION, AND MONITORING
ANNUAL COST

Item	Item Cost Years 1 through 3	Item Cost Years 4 through 6	Item Cost Every 5 Years	Notes
Quarterly Groundwater Sampling	$14,520			8 Wells at Site 6A plus 4 Wells at Site 10B, 4 times, Labor
Quarterly Groundwater Analysis	$44,200			8 Wells at Site 6A plus 4 Wells at Site 10B, 4 Times, VOCs, SVOCs, PAHs, Water Quality Parameters
Annual Groundwater Sampling		$3,630		8 Wells at Site 6A plus 4 Wells at Site 10B, Labor
Annual Groundwater Analysis		$11,050		8 Wells at Site 6A plus 4 Wells at Site 10B, VOCs, SVOCs, PAHs, Water Quality Parameters
Inspection	$1,000	$1,000		Annual LUC inspection (assume 8 hours at $50/hr plus expenses)
Site Review			$23,000	5-year review
TOTALS	$59,720	$15,680	$23,000	

SITE 6A - FUEL CALIBRATION AREA, SITE 10B - ENGINE TEST HOUSE, AND ONSITE SOUTHERN AREA
NWIRP CALVERTON
CALVERTON, NEW YORK
ALT SAGW5: LAND USE CONTROLS / DEED NOTIFICATIONS, IN-SITU BIOLOGICAL TREATMENT (BIOSTIMULATION WITH HRC AND ORC), NATURAL ATTENTUATION, AND MONITORING
PRESENT WORTH ANALYSIS

Year	Capital Cost	Annual Cost	Total Year Cost	Annual Discount Rate at 7%	Present Worth
0	$1,898,553		$1,898,553	1.000	$1,898,553
1		$59,720	$59,720	0.935	$55,838
2		$59,720	$59,720	0.873	$52,136
3		$59,720	$59,720	0.816	$48,732
4		$15,680	$15,680	0.763	$11,964
5		$38,680	$38,680	0.713	$27,579
6		$15,680	$15,680	0.666	$10,443
				TOTAL PRESENT WORTH	$2,105,244

D.11 - ALTERNATIVE OSAGP2
LAND USE CONTROLS/DEED NOTIFICATIONS, NATURAL ATTENUATION, AND MONITORING

SITE 6A - FUEL CALIBRATION AREA, SITE 10B - ENGINE TEST HOUSE, AND ONSITE SOUTHERN AREA
NWIRP CALVERTON
CALVERTON, NEW YORK
ALT OSAGP2: LAND USE CONTROLS / DEED NOTIFICATIONS, NATURAL ATTENTUATION, AND MONITORING
CAPITAL COST

Item	Quantity	Unit	Unit Cost				Extended Cost				Subtotal
			Subcontract	Material	Labor	Equipment	Subcontract	Material	Labor	Equipment	
1 PROJECT PLANNING											
1.1 Prepare Remedial Action Plan	100	hr			$52.50		$0	$0	$5,250	$0	$5,250
1.2 Land Use Controls / Deed Notifications	150	hr			$52.50		$0	$0	$7,875	$0	$7,875
2 MOBILIZATION/DEMOBILIZATION AND SURVEY											
2.1 Construction Survey	1	ls	$1,000.00				$1,000	$0	$0	$0	$1,000
2.2 Drill Rig Mobilization/Demobilization	1	ls	$5,000.00				$5,000	$0	$0	$0	$5,000
3 MONITORING WELL INSTALLATION											
3.1 Install Monitoring Wells, 10 wells, 30 ft each	300	ft	$35.00				$10,500	$0	$0	$0	$10,500
3.2 Flushmounts	10	ea	$120.00				$1,200	$0	$0	$0	$1,200
3.3 Collect/Containerize IDW	10	ea	$50.00				$500	$0	$0	$0	$500
3.4 Transport/Dispose IDW Off Site	10	drums	$150.00				$1,500	$0	$0	$0	$1,500
4 MISCELLANEOUS											
4.1 Prepare Post-Construction Documents	20	hours			$52.50		$0	$0	$1,050	$0	$1,050
4.2 Construction Oversight (2p * 2 week)	4	mn-wks			$1,200.00		$0	$0	$4,800	$0	$4,800
Subtotal							$19,700	$0	$18,975	$0	$38,675
Local Area Adjustments							100.0%	112.3%	130.4%	130.4%	
							$19,700	$0	$24,743	$0	$44,443
Overhead on Labor Cost @ 30%									$7,423		$7,423
G & A on Labor Cost @ 10%									$2,474		$2,474
G & A on Material Cost @ 10%								$0			$0
G & A on Subcontract Cost @ 10%							$1,970				$1,970
G & A on Equipment Cost @ 10%										$0	$0
Total Direct Cost							$21,670	$0	$34,641	$0	$56,311
Indirects on Total Direct Cost @ 35%			(Total Direct Cost Minus Transportation and Disposal Costs)								$19,184
Profit on Total Direct Cost @ 10%											$5,631
Subtotal											$81,126
Health & Safety Monitoring @ 2%											$1,623
Total Field Cost											$82,748
Contingency on Total Field Costs @ 15%											$12,412
Engineering on Total Field Cost @ 15%											$12,412
TOTAL COST											**$107,573**

SITE 6A - FUEL CALIBRATION AREA, SITE 10B - ENGINE TEST HOUSE, AND ONSITE SOUTHERN AREA
NWIRP CALVERTON
CALVERTON, NEW YORK
ALT OSAGP2: LAND USE CONTROLS / DEED NOTIFICATIONS, NATURAL ATTENTUATION, AND MONITORING
ANNUAL COST

Item	Item Cost Year 1	Item Cost Years 2 through 30	Item Cost Every 5 Years	Notes
Quarterly Groundwater Sampling	$13,080			10 Wells, 4 times, Labor
Quarterly Groundwater Analysis	$36,840			10 Wells, 4 Times, VOCs, SVOCs, PAHs, Water Quality Parameters
Annual Groundwater Sampling		$3,270		10 Wells, Labor
Annual Groundwater Analysis		$9,210		10 Wells, VOCs, SVOCs, PAHs, Water Quality Parameters
Annual Report	$10,000	$10,000		
Inspection	$1,000	$1,000		Annual LUC inspection (assume 8 hours at $50/hr plus expenses)
Site Review			$23,000	5-year review
TOTALS	$60,920	$23,480	$23,000	

SITE 6A - FUEL CALIBRATION AREA, SITE 10B - ENGINE TEST HOUSE, AND ONSITE SOUTHERN AREA
NWIRP CALVERTON
CALVERTON, NEW YORK
ALT OSAGP2: LAND USE CONTROLS / DEED NOTIFICATIONS, NATURAL ATTENTUATION, AND MONITORING
PRESENT WORTH ANALYSIS

Year	Capital Cost	Annual Cost	Total Year Cost	Annual Discount Rate at 7%	Present Worth
0	$107,573		$107,573	1.000	$107,573
1		$60,920	$60,920	0.935	$56,960
2		$23,480	$23,480	0.873	$20,498
3		$23,480	$23,480	0.816	$19,160
4		$23,480	$23,480	0.763	$17,915
5		$46,480	$46,480	0.713	$33,140
6		$23,480	$23,480	0.666	$15,638
7		$23,480	$23,480	0.623	$14,628
8		$23,480	$23,480	0.582	$13,665
9		$23,480	$23,480	0.544	$12,773
10		$46,480	$46,480	0.508	$23,612
11		$23,480	$23,480	0.475	$11,153
12		$23,480	$23,480	0.444	$10,425
13		$23,480	$23,480	0.415	$9,744
14		$23,480	$23,480	0.388	$9,110
15		$46,480	$46,480	0.362	$16,826
16		$23,480	$23,480	0.339	$7,960
17		$23,480	$23,480	0.317	$7,443
18		$23,480	$23,480	0.296	$6,950
19		$23,480	$23,480	0.277	$6,504
20		$46,480	$46,480	0.258	$11,992
21		$23,480	$23,480	0.242	$5,682
22		$23,480	$23,480	0.226	$5,306
23		$23,480	$23,480	0.211	$4,954
24		$23,480	$23,480	0.197	$4,626
25		$46,480	$46,480	0.184	$8,552
26		$23,480	$23,480	0.172	$4,039
27		$23,480	$23,480	0.161	$3,780
28		$23,480	$23,480	0.150	$3,522
29		$23,480	$23,480	0.141	$3,311
30		$46,480	$46,480	0.131	$6,089
				TOTAL PRESENT WORTH	$483,530

D.12 - ALTERNATIVE OSAGP3

LAND USE CONTROLS/DEED NOTIFICATIONS, GROUNDWATER EXTRACTION (WELLS), TREATMENT (AIR STRIPPING/ACTIVATED CARBON), AND RE-INJECTION (INFILTRATION GALLERIES), AND MONITORING

SITE 6A - FUEL CALIBRATION AREA, SITE 10B - ENGINE TEST HOUSE, AND ONSITE SOUTHERN AREA
NWIRP CALVERTON
CALVERTON, NEW YORK
ALT OSAGP3: LAND USE CONTROLS / DEED NOTIFICATIONS, GROUNDWATER EXTRACTION (WELLS), TREATMENT (AIR STRIPPING / ACTIVATED CARBON), RE-INJECTION (INFILTRATION GALLERIES), AND MONITORING
CAPITAL COST

Item	Quantity	Unit	Unit Cost				Extended Cost				Subtotal
			Subcontract	Material	Labor	Equipment	Subcontract	Material	Labor	Equipment	
1 PROJECT PLANNING AND MOBILIZATION/DEMOBILIZATION											
1.1 Prepare Documents & Plans including Permits	300	hr			$52.50		$0	$0	$15,750	$0	$15,750
1.2 Land Use Controls / Deed Notifications	150	hr			$52.50		$0	$0	$7,875	$0	$7,875
2 MOBILIZATION/DEMOBILIZATION AND FIELD SUPPORT											
2.1 Office Trailer	3	mo				$202.50	$0	$0	$0	$608	$608
2.2 Office Trailer Mob/Demo	1	ea				$225.00	$0	$0	$0	$225	$225
2.3 Field Office Support	3	mo		$143.00			$0	$429	$0	$0	$429
2.4 Electrical Hook-up / Power Source	1	ls	$20,000.00				$20,000	$0	$0	$0	$20,000
2.5 Site Utilities (Phone & Electric)	3	mo		$302.00			$0	$906	$0	$0	$906
2.6 Drill Rig Mobilization/Demobilization	1	ls	$3,000.00				$3,000	$0	$0	$0	$3,000
2.7 Mobilization/Demobilization Construction Equipment	1	ea			$110.00	$224.00	$0	$0	$110	$224	$334
3 DECONTAMINATION											
3.1 Temporary Decon Pad	1	ls		$500.00	$450.00	$155.00	$0	$500	$450	$155	$1,105
3.2 Decontamination Services	2	mo		$210.00	$1,800.00	$315.00	$0	$420	$3,600	$630	$4,650
3.3 Decon Water	2,000	gal		$0.20			$0	$400	$0	$0	$400
3.4 Decon Water Storage Tank, 6,000 gallon	2	mo				$645.00	$0	$0	$0	$1,290	$1,290
3.5 Clean Water Storage Tank, 4,000 gallon	2	mo				$580.00	$0	$0	$0	$1,160	$1,160
3.6 Disposal of Decon Waste (Liquid & Solid)	2	mo	$900.00				$1,800	$0	$0	$0	$1,800
4 MONITORING WELL INSTALLATION											
4.1 Install Monitoring Wells, 10 wells, 30 ft each	300	ft	$35.00				$10,500	$0	$0	$0	$10,500
4.2 Flushmounts	10	ea	$120.00				$1,200	$0	$0	$0	$1,200
4.3 Collect/Containerize IDW	10	ea	$50.00				$500	$0	$0	$0	$500
4.4 Transport/Dispose IDW Off Site	10	drums	$150.00				$1,500	$0	$0	$0	$1,500
5 ON-SITE SOUTHERN AREA PLUME WELL INSTALLATION											
5.1 Extraction Wells (5 wells, 6" dia. @ 60' deep)	300	lf	$100.00				$30,000	$0	$0	$0	$30,000
5.2 Submersible Centrifugal Pumps (40 gpm, 100 ft head, 1.5 HP)	5	ea		$2,183.00			$0	$10,915	$0	$0	$10,915
5.3 Excavate/Backfill Pipe 4' Deep Trench	500	lf			$2.74	$0.79	$0	$0	$1,370	$395	$1,765
5.4 4-inch Dia. PVC Piping	500	ft		$5.99	$5.75	$9.45	$0	$2,997	$2,875	$4,725	$10,597
6 ON-SITE SOUTHERN AREA PLUME TREATMENT SYSTEM											
6.1 Building Foundation	1,000	sf	$4.06				$4,060	$0	$0	$0	$4,060
6.2 Treatment Building	1,000	sf	$11.58				$11,580	$0	$0	$0	$11,580
6.3 Building Misc. (doors/vent/insulation/misc.)	1	ls	$6,012.00				$6,012	$0	$0	$0	$6,012
6.4 12 Ft Dia Equalization Tank (7,300 gal))	1	ea		$9,094.80	$2,306.70	$2.86	$0	$9,095	$2,307	$3	$11,404
6.5 Top Mounted Low-Speed Turbine-Type Mixer (3.6 hp)	1	ea		$22,417.00			$0	$22,417	$0	$0	$22,417
6.6 Horizontal-Centrifugal Pump, 120 gpm, 10 HP, 100 ft head	3	ea		$1,290.00	$634.57		$0	$3,870	$1,904	$0	$5,774
6.7 20 Ft Diameter, 19,000 Gallon Clarifier Tank	2	ea		$67,500.00	$27,928.00	$9,182.00	$0	$135,000	$55,856	$18,364	$209,220
6.8 Bag Filter, Multi-Bag, 182 sf total	2	ea		$1,015.94			$0	$2,032	$0	$0	$2,032
6.9 Air Stripper, 240 gpm, 1800 cfm Blower & Control Panel	1	ea		$45,000.00			$0	$45,000	$0	$0	$45,000
6.10 Caustic Feed System	1	ea		$8,655.00	$2,165.00		$0	$8,655	$2,165	$0	$10,820
6.11 Potassium Permanganate Feed System	1	ea		$1,085.00	$2,165.00		$0	$1,085	$2,165	$0	$3,250
6.12 Plumb/Electrify System	1	ls		$6,000.00	$6,528.00		$0	$6,000	$6,528	$0	$12,528
6.13 System Start-Up and Testing	1	ls		$1,000.00	$1,750.00		$0	$1,000	$1,750	$0	$2,750
6.14 Excavate/Backfill Pipe 4' Deep Trench to Infilration Beds	1,800	lf			$2.74	$0.79	$0	$0	$4,932	$1,422	$6,354
6.15 2-inch Dia. PVC Piping to Infiltration Beds	1,800	ft		$1.72	$3.93	$6.45	$0	$3,089	$7,074	$11,610	$21,773
6.16 Excavate/Backfill Pipe 4' Deep Trench / Infiltration Beds	4,000	lf			$2.74	$0.79	$0	$0	$10,960	$3,160	$14,120
6.17 Geotextile for Infiltration Beds	1,336	sy		$1.28	$0.18		$0	$1,710	$240	$0	$1,951
6.18 Gravel Layer, 8 Beds, Each 500 Ft Long, 6 Inches x 1 Ft	72	cy		$27.50	$2.47	$4.22	$0	$1,980	$178	$304	$2,462
6.19 2-inch Dia. PVC Piping, Perforated	4,000	ft		$2.57	$3.93	$6.45	$0	$10,296	$15,720	$25,800	$51,816

SITE 6A - FUEL CALIBRATION AREA, SITE 10B - ENGINE TEST HOUSE, AND ONSITE SOUTHERN AREA
NWIRP CALVERTON
CALVERTON, NEW YORK
ALT OSAGP3: LAND USE CONTROLS / DEED NOTIFICATIONS, GROUNDWATER EXTRACTION (WELLS), TREATMENT (AIR STRIPPING / ACTIVATED CARBON), RE-INJECTION (INFILTRATION GALLERIES), AND MONITORING
CAPITAL COST

Item	Quantity	Unit	Unit Cost				Extended Cost				Subtotal
			Subcontract	Material	Labor	Equipment	Subcontract	Material	Labor	Equipment	
7 MISCELLANEOUS											
7.1 Construction Oversite (2p * 3 months)	126	mn-days			$240.00		$0	$0	$30,240	$0	$30,240
7.2 Post Construction Documents	125	hr			$52.50		$0	$0	$6,563	$0	$6,563
7.3 Vegetate Disturbed Areas	1	ls		$600.00	$1,000.00	$400.00	$0	$600	$1,000	$400	$2,000
Subtotal							$90,152	$268,395	$181,611	$70,474	$610,632
Local Area Adjustments							100.0%	112.3%	130.4%	130.4%	
							$90,152	$301,408	$236,821	$91,898	$720,279
Overhead on Labor Cost @ 30%									$71,046		$71,046
G & A on Labor Cost @ 10%									$23,682		$23,682
G & A on Material Cost @ 10%								$30,141			$30,141
G & A on Equipment Cost @ 10%										$9,190	$9,190
G & A on Subcontract Cost @ 10%							$9,015				$9,015
Total Direct Cost							$99,167	$331,548	$331,549	$101,088	$863,353
Indirects on Total Direct Cost @ 35%			(Total Direct Cost Minus Transportation and Disposal Costs)								$301,019
Profit on Total Direct Cost @ 10%											$86,335
Subtotal											$1,250,707
Health & Safety Monitoring @ 2%											$25,014
Total Field Cost											$1,275,721
Contingency on Subtotal Cost @ 25%											$318,930
Engineering on Subtotal Cost @ 15%											$191,358
TOTAL COST											**$1,786,010**

SITE 6A - FUEL CALIBRATION AREA, SITE 10B - ENGINE TEST HOUSE, AND ONSITE SOUTHERN AREA
NWIRP CALVERTON
CALVERTON, NEW YORK
ALT OSAGP3: LAND USE CONTROLS / DEED NOTIFICATIONS, GROUNDWATER EXTRACTION (WELLS), TREATMENT (AIR STRIPPING / ACTIVATED CARBON), RE-INJECTION (INFILTRATION GALLERIES), AND MONITORING
OPERATION AND MAINTENANCE COSTS PER YEAR

	Item	Qty	Unit	Unit Cost	Subtotal Cost	Notes
	Year 1					
1	Energy - Electric	229,285	kWh	$0.12	$27,514	
2	Maintenance	1	ls	$21,729.25	$21,729	5% of Installation Cost
3	Labor, Per Diem, Supplies	52	day	$350.00	$18,200	1 visit per week - 1 day
4	Caustic Soda	20	ton	$435.00	$8,700	
5	Potassium Permanganate	9000	lb	$1.65	$14,850	
6	Influent (Five Wells) and Effluent Sampling	90	ea	$617.50	$55,575	Weekly for first month, then once a month each for VOCs, SVOCs, and PAHs, + 30% for quality assurance
7	Semi-Annual Reports	2	ea	$4,000.00	$8,000	
	Subtotal Cost for One Year Operation				$154,568	
	Years 2 through 11					
1	Energy - Electric	229,285	kWh	$0.12	$27,514	
2	Maintenance	1	ls	$21,729.25	$21,729	5% of Installation Cost
3	Labor, Per Diem, Supplies	52	day	$350.00	$18,200	1 visit per week - 1 day
4	Caustic Soda	20	ton	$435.00	$8,700	
5	Potassium Permanganate	9000	lb	$1.65	$14,850	
6	Influent (Five Wells) and Effluent Sampling	72	ea	$617.50	$44,460	Once/month each for VOCs, SVOCs, and PAHs, + 30% for QA
7	Semi-Annual Reports	2	ea	$4,000.00	$8,000	
	Subtotal Cost for One Year Operation				$143,453	

SITE 6A - FUEL CALIBRATION AREA, SITE 10B - ENGINE TEST HOUSE, AND ONSITE SOUTHERN AREA
NWIRP CALVERTON
CALVERTON, NEW YORK
ALT OSAGP3: LAND USE CONTROLS / DEED NOTIFICATIONS, GROUNDWATER EXTRACTION (WELLS), TREATMENT (AIR STRIPPING / ACTIVATED CARBON), RE-INJECTION (INFILTRATION GALLERIES), AND MONITORING
ANNUAL COST

Item	Item Cost Year 1	Item Cost Years 2 through 11	Item Cost Every 5 Years	Notes
Quarterly Groundwater Sampling	$13,080			10 Wells, 4 times, Labor
Quarterly Groundwater Analysis	$36,840			10 Wells, 4 Times, VOCs, SVOCs, PAHs, Water Quality Parameters
Annual Groundwater Sampling		$3,270		10 Wells, Labor
Annual Groundwater Analysis		$9,210		10 Wells, VOCs, SVOCs, PAHs, Water Quality Parameters
Annual Report	$10,000	$10,000		
Inspection	$1,000	$1,000		Annual LUC inspection (assume 8 hours at $50/hr plus expenses)
Site Review			$23,000	5-year review
TOTALS	$60,920	$23,480	$23,000	

SITE 6A - FUEL CALIBRATION AREA, SITE 10B - ENGINE TEST HOUSE, AND ONSITE SOUTHERN AREA
NWIRP CALVERTON
CALVERTON, NEW YORK
ALT OSAGP3: LAND USE CONTROLS / DEED NOTIFICATIONS, GROUNDWATER EXTRACTION (WELLS), TREATMENT (AIR STRIPPING / ACTIVATED CARBON), RE-INJECTION (INFILTRATION GALLERIES), AND MONITORING
PRESENT WORTH ANALYSIS

Year	Capital Cost	Operation and Maintenance Cost	Annual Cost	Total Year Cost	Annual Discount Rate at 7%	Present Worth
0	$1,786,010			$1,786,010	1.000	$1,786,010
1		$154,568	$60,920	$215,488	0.935	$201,482
2		$143,453	$23,480	$166,933	0.873	$145,733
3		$143,453	$23,480	$166,933	0.816	$136,218
4		$143,453	$23,480	$166,933	0.763	$127,370
5		$143,453	$46,480	$189,933	0.713	$135,423
6		$143,453	$23,480	$166,933	0.666	$111,178
7		$143,453	$23,480	$166,933	0.623	$104,000
8		$143,453	$23,480	$166,933	0.582	$97,155
9		$143,453	$23,480	$166,933	0.544	$90,812
10		$143,453	$46,480	$189,933	0.508	$96,486
11		$143,453	$23,480	$166,933	0.475	$79,293

TOTAL PRESENT WORTH **$3,111,159**

D.13 - ALTERNATIVE OSAGP4

LAND USE CONTROLS/DEED NOTIFICATIONS, IN-SITU BIOLOGICAL TREATMENT (BIOBARRIER WITH HRC), NATURAL ATTENUATION, AND MONITORING

SITE 6A - FUEL CALIBRATION AREA, SITE 10B - ENGINE TEST HOUSE, AND ONSITE SOUTHERN AREA
NWIRP CALVERTON
CALVERTON, NEW YORK
ALT OSAGP4: LAND USE CONTROLS / DEED NOTIFICATIONS, IN-SITU BIOLOGICAL TREATMENT (BIOBARRIER WITH HRC), NATURAL ATTENTUATION, AND MONITORING
CAPITAL COST - WELLS

Item	Quantity	Unit	Unit Cost				Extended Cost				Subtotal
			Subcontract	Material	Labor	Equipment	Subcontract	Material	Labor	Equipment	
1 PROJECT PLANNING											
1.1 Prepare Remedial Action Plan	100	hr			$52.50		$0	$0	$5,250	$0	$5,250
1.2 Land Use Controls / Deed Notifications	150	hr			$52.50		$0	$0	$7,875	$0	$7,875
1.3 Pilot Study	1	ls	$3,000.00	$147,000.00			$3,000	$147,000	$0	$0	$150,000
2 MOBILIZATION/DEMOBILIZATION AND SURVEY											
2.1 Construction Survey	1	ls	$1,000.00				$1,000	$0	$0	$0	$1,000
2.2 Drill Rig Mobilization/Demobilization	1	ls	$5,000.00				$5,000	$0	$0	$0	$5,000
3 MONITORING WELL INSTALLATION											
3.1 Install Monitoring Wells, 10 wells, 30 ft each	300	ft	$35.00				$10,500	$0	$0	$0	$10,500
3.2 Flushmounts	10	ea	$120.00				$1,200	$0	$0	$0	$1,200
3.3 Collect/Containerize IDW	10	ea	$50.00				$500	$0	$0	$0	$500
3.4 Transport/Dispose IDW Off Site	10	drums	$150.00				$1,500	$0	$0	$0	$1,500
4 MISCELLANEOUS											
4.1 Prepare Post-Construction Documents	20	hours			$52.50		$0	$0	$1,050	$0	$1,050
4.2 Construction Oversight (2p * 2week)	4	mn-wks			$1,200.00		$0	$0	$4,800	$0	$4,800
Subtotal							$22,700	$147,000	$18,975	$0	$188,675
Local Area Adjustments							100.0%	112.3%	130.4%	130.4%	
							$22,700	$165,081	$24,743	$0	$212,524
Overhead on Labor Cost @ 30%									$7,423		$7,423
G & A on Labor Cost @ 10%									$2,474		$2,474
G & A on Material Cost @ 10%								$16,508			$16,508
G & A on Subcontract Cost @ 10%							$2,270				$2,270
G & A on Equipment Cost @ 10%										$0	$0
Total Direct Cost							$24,970	$181,589	$34,641	$0	$241,200
Indirects on Total Direct Cost @ 35%			(Total Direct Cost Minus Transportation and Disposal Costs)								$83,895
Profit on Total Direct Cost @ 10%											$24,120
Subtotal											$349,215
Health & Safety Monitoring @ 2%											$6,984
Total Field Cost											$356,199
Contingency on Total Field Costs @ 25%											$89,050
Engineering on Total Field Cost @ 15%											$53,430
TOTAL COST											**$498,679**

SITE 6A - FUEL CALIBRATION AREA, SITE 10B - ENGINE TEST HOUSE, AND ONSITE SOUTHERN AREA
NWIRP CALVERTON
CALVERTON, NEW YORK
ALT OSAGP4: LAND USE CONTROLS / DEED NOTIFICATIONS, IN-SITU BIOLOGICAL TREATMENT (BIOBARRIER WITH HRC), NATURAL ATTENTUATION, AND MONITORING
CAPITAL COST - HRC

Item	Quantity	Unit	Unit Cost				Extended Cost				Subtotal
			Subcontract	Material	Labor	Equipment	Subcontract	Material	Labor	Equipment	
1 PROJECT PLANNING											
1.1 Prepare Remedial Action Plan	100	hr			$52.50		$0	$0	$5,250	$0	$5,250
2 MOBILIZATION/DEMOBILIZATION AND FIELD SUPPORT											
2.1 Office Trailer	3	mo		$202.50			$0	$608	$0	$0	$608
2.2 Storage Trailer	3	mo		$105.00			$0	$315	$0	$0	$315
2.3 Construction Survey	2	ac	$1,200.00				$2,400	$0	$0	$0	$2,400
2.4 DPT Rig Mobilization/Demobilization	1	ea	$3,000.00				$3,000	$0	$0	$0	$3,000
2.5 Site Utilities	3	mo		$427.00			$0	$1,281	$0	$0	$1,281
3 DECONTAMINATION											
3.1 Temporary Decon Pad	1	ls		$500.00	$450.00	$155.00	$0	$500	$450	$155	$1,105
3.2 Decontamination Services	3	mo		$210.00	$1,800.00	$315.00	$0	$630	$5,400	$945	$6,975
3.3 Decon Water	3,000	gal		$0.20			$0	$600	$0	$0	$600
3.4 Decon Water Storage Tank, 6,000 gallon	3	mo				$645.00	$0	$0	$0	$1,935	$1,935
3.5 Clean Water Storage Tank, 4,000 gallon	3	mo				$580.00	$0	$0	$0	$1,740	$1,740
3.6 Disposal of Decon Waste (Liquid & Solid)	3	mo	$900.00				$2,700	$0	$0	$0	$2,700
4 HRC INJECTION - SITE 6A & SITE 10B											
4.1 HRC Injection (445 points @ 40' deep)	50	day	$3,070.00				$153,500	$0	$0	$0	$153,500
4.2 HRC Material	122,000	lb		$5.86			$0	$714,920	$0	$0	$714,920
4.3 Waste/Soil Disposal	1	ls	$3,000.00				$3,000	$0	$0	$0	$3,000
5 MISCELLANEOUS											
5.1 Prepare Post-Construction Documents	150	hours			$52.50		$0	$0	$7,875	$0	$7,875
8.2 Construction Oversight (2p * 3 months)	126	mn-days			$240.00		$0	$0	$30,240	$0	$30,240
Subtotal							$164,600	$718,854	$49,215	$4,775	$937,444
Local Area Adjustments							100.0%	112.3%	130.4%	130.4%	
							$164,600	$807,272	$64,176	$6,227	$1,042,275
Overhead on Labor Cost @ 30%									$19,253		$19,253
G & A on Labor Cost @ 10%									$6,418		$6,418
G & A on Material Cost @ 10%								$80,727			$80,727
G & A on Subcontract Cost @ 10%							$16,460				$16,460
G & A on Equipment Cost @ 10%										$623	$623
Total Direct Cost							$181,060	$888,000	$89,847	$6,849	$1,165,756
Indirects on Total Direct Cost @ 25%			(Total Direct Cost Minus Transportation and Disposal Costs)								$290,014
Profit on Total Direct Cost @ 10%											$116,576
Subtotal											$1,572,345
Health & Safety Monitoring @ 1%											$15,723
Total Field Cost											$1,588,069
Contingency on Total Field Costs @ 25%											$397,017
Engineering on Total Field Cost @ 5%											$79,403
TOTAL COST (for Years 0 through 10)											**$2,064,490**

SITE 6A - FUEL CALIBRATION AREA, SITE 10B - ENGINE TEST HOUSE, AND ONSITE SOUTHERN AREA
NWIRP CALVERTON
CALVERTON, NEW YORK
ALT OSAGP4: LAND USE CONTROLS / DEED NOTIFICATIONS, IN-SITU BIOLOGICAL TREATMENT (BIOBARRIER WITH HRC), NATURAL ATTENTUATION, AND MONITORING
ANNUAL COST

Item	Item Cost Year 1	Item Cost Years 2 through 10	Item Cost Every 5 Years	Notes
Quarterly Groundwater Sampling	$13,080			10 Wells, 4 times, Labor
Quarterly Groundwater Analysis	$36,840			10 Wells, 4 Times, VOCs, SVOCs, PAHs, Water Quality Parameters
Annual Groundwater Sampling		$3,270		10 Wells, Labor
Annual Groundwater Analysis		$9,210		10 Wells, VOCs, SVOCs, PAHs, Water Quality Parameters
Annual Report	$10,000	$10,000		
Inspection	$1,000	$1,000		Annual LUC inspection (assume 8 hours at $50/hr plus expenses)
Site Review			$23,000	5-year review
TOTALS	$60,920	$23,480	$23,000	

SITE 6A - FUEL CALIBRATION AREA, SITE 10B - ENGINE TEST HOUSE, AND ONSITE SOUTHERN AREA
NWIRP CALVERTON
CALVERTON, NEW YORK
ALT OSAGP4: LAND USE CONTROLS / DEED NOTIFICATIONS, IN-SITU BIOLOGICAL TREATMENT (BIOBARRIER WITH HRC), NATURAL ATTENTUATION, AND MONITORING
PRESENT WORTH ANALYSIS

Year	Capital Cost	Annual Cost	Total Year Cost	Annual Discount Rate at 7%	Present Worth
0	$2,563,168		$2,563,168	1.000	$2,563,168
1	$2,064,490	$60,920	$2,125,410	0.935	$1,987,258
2	$2,064,490	$23,480	$2,087,970	0.873	$1,822,797
3	$2,064,490	$23,480	$2,087,970	0.816	$1,703,783
4	$2,064,490	$23,480	$2,087,970	0.763	$1,593,121
5	$2,064,490	$46,480	$2,110,970	0.713	$1,505,121
6	$2,064,490	$23,480	$2,087,970	0.666	$1,390,588
7	$2,064,490	$23,480	$2,087,970	0.623	$1,300,805
8	$2,064,490	$23,480	$2,087,970	0.582	$1,215,198
9	$2,064,490	$23,480	$2,087,970	0.544	$1,135,855
10	$2,064,490	$46,480	$2,110,970	0.508	$1,072,373
				TOTAL PRESENT WORTH	$17,290,068